SCIENCE ABSTRACTS.

Section A.—PHYSICS.

FEBRUARY, 1930.

GENERAL PHYSICS.

429. Pressure-Controlled McLeod Gauge. N. Underwood. *J.O.S.A. and R.S.I.* 19. *p.* 78, *Aug.*, 1929.

The mercury is controlled by means of an atomiser bulb with good rubber valves, which can be used to force air into the space above the mercury in the lower reservoir through a tube provided with a valve and an air filter, to prevent contamination of the mercury. The pressure can be relieved when necessary by opening a stopcock. H. N. A.

430. New Differential Pressure Gauge. A. R. Olson and L. L. Hirst. *Am. Chem. Soc., J.* 51. *pp.* 2378–2379, *Aug.*, 1929.

A new simple and accurate differential pressure gauge has been devised which will permit the study of very slow reactions at any pressure, even when an all-glass gauge is needed. Full details, with two diagrams, are given. H. H. Ho.

431. Pressure Gauge for Continuous Reading in Moderate Vacua. M. C. Johnson and G. O. Harrison. *Journ. Sci. Instruments,* 6. *pp.* 305–308, *Oct.*, 1929.

The construction and use of a continuous-reading pressure gauge for low-pressure gas experiments is described. Pressure differences between ½ mm. and 2×10^{-4} mm. of mercury are measurable. AUTHORS.

432. New "Turbine" Gas Meter. J. L. Hodgson. *Journ. Sci. Instruments,* 6. *pp.* 258–261, *Aug.*, 1929.

A form of shunt gas meter is described employing a jet-driven turbine, a magnetic drive transmitting the motion of the turbine to the counting mechanism, and its mode of installation is illustrated. Meters for all diameters of main from 4 to 30 in. are 2 ft. long. The indications of the meter can be checked by means of a manometer connected across the meter orifice. The accuracy of calibration is ± 1 %. J. S. G. T.

433. New Pendulum with Constant Time of Vibration. M. Schuler. *Zeits. f. techn. Physik,* 10. 9. *pp.* 392–395, 1929.

The pendulum consists of a rod to the ends of which are attached two heavy masses, the whole being of invar steel. A knife-edge suspension is fixed to the rod in such a position that the time of vibration is a minimum. At this point the rate of change of the period for minute shifts of the suspension along the rod in either direction is zero, and it remains very small for some appreciable distance on either side. The result is that long wear of the suspension does not in practice affect the time of vibration. Friction is reduced by surrounding the pendulum with an atmosphere of hydrogen, the pressure of which is somewhat reduced but is not brought to zero, as it serves to bring the temperature of the pendulum to the same point as that of its case. The pendulum synchronises a working clock on which the time is read, but there is no mechanical connection between the two, a beam of light, a photocell and an amplifier being used for this purpose. The motion of the pendulum is kept up electromagnetically: currents in an electromagnet which acts on a small permanent magnet attached to the pendulum are switched in the proper direction at the right moments by the working clock. It is expected that clock errors will be reduced to about one-tenth of those of the best existing clocks. H. N. A.

434. Determination of Temperature and Atmospheric Density Constants of Gravitation Pendulums by the Two-Pendulum Method. H. Schmehl and W. Jenne. *Zeits. f. Instrumentenk*, 49. *pp.* 396–406, *Aug.*, 1929.

Describes a vacuum apparatus in which four pendulums can be observed, and the optical methods employed in observing coincidences. In the present investigation only one pair of pendulums was made use of. It was found that the use of the double-pendulum method had the following advantages over the usual one in which only a single pendulum is used: the time required for the observations is halved, the accuracy of the determination of the constants is increased and the working up of the results is simplified. H. N. A.

435. New Apparatus for Investigating Continued Bending Vibrations. H. Gerdien. *Zeits. f. techn. Physik*, 10. 9. *pp.* 389–392, 1929.

Describes an apparatus in which a rod of the material to be tested is subjected to alternating stresses by means of four magnetic poles, which act on a mass of laminated iron fixed to its top. The poles are placed at right angles to one another, and the alternate pairs are wound with coils in which circulate alternating currents the phases of which are displaced 90° with regard to one another, so that the iron armature is subjected to torsional vibrations. These can be made so intense, and can be continued so long, that the rod finally breaks. At the same time arrangements are made for taking the temperature of the material in the region where the stresses are a maximum by means of a thermocouple, the idea being that the way in which the temperature increases will be a guide to the life of the rod under particular stress conditions, so that it will not be necessary to continue tests of future specimens of similar nature to the actual breaking point, this being deduced from the way in which the temperature rises during a short test. It is possible also to test the rods at a high temperature. H. N. A.

436. Surface Tension of Mercury in Presence of Gas Under Varying Pressures. S. G. Cook. *Phys. Rev.* 34. *pp.* 513–520, *Aug.* 1, 1929.

Quincke's method with Worthington's correction was used. Contrary to the accepted values the maximum surface tension of mercury (515 ± 7 dynes/cm. at 31° C.) is reached when only mercury vapour is present. A surface freshly created in a gas at 760 mm. has a high initial tension approaching that when the surface is created in mercury vapour.

The tension falls as the gas is adsorbed until an equilibrium value for a given pressure is attained. As the pressure is reduced the equilibrium value rises to a maximum which depends upon the nature of the gas. For instance, this maximum tension for mercury-hydrogen occurs at the critical pressure of 2·8 mm. If the pressure is lowered to stiction, the tension remains unchanged so long as the mercury is not agitated beyond a certain amount. This maximum value for mercury-hydrogen is 441 dynes/cm., which is less than the mercury-mercury vapour value of 515 dynes/cm. If the mercury-hydrogen is violently agitated when the pressure has been reduced to stiction, the tension approaches 515 dynes/cm., the mercury-mercury vapour tension. Vibrating drop methods tend to give the vacuum value of the surface tension even when a gas is present at atmospheric pressure. AUTHOR.

437. Ring Method for Determining Surface Tension. A. H. Nietz and R. H. Lambert. *J. Phys. Chem.* 33. *pp.* 1460–1467, *Oct.*, 1929.

The ring method for surface-tension measurement was investigated as to the effect of dimensions of the ring and as to the effect of contact angle. It was definitely proved that there is a relation between the pull on the ring and the angle of contact between the material of the ring and the liquid. The form of the function showing this relationship was found to be $F = 2lT(1 + \cos\theta)^n$, though this did not hold over the entire range of wire sizes. The classification of the ring method as being free from the effect of contact angle is definitely in error, being probably partly caused by an accidental choice of rings and materials which showed little if any effect. AUTHORS.

438. Surface Tension. A. W. Porter. *Phil. Mag.* 8. *pp.* 180–186, *Aug.*, 1929.

In a previous paper [see Abstract 2059 (1929)] the method of dimensions was applied briefly to drops from cylindrical tubes, and the present note records an examination of the mechanics of a sustained drop for such a tube. It is found that under the assumed conditions, and for a given outside radius of the tube, one and only one initial curvature corresponds to a pendant-drop of a definite fluid in equilibrium; consequently, one and only one weight of pendant-drop can be in equilibrium near the end of a tube of given outside radius of curvature. H. H. Ho.

439. Shapes of Drops and Determination of Surface Tension. B. B. Freud and W. D. Harkins. *J. Phys. Chem.* 33. *pp.* 1217–1234, *Aug.*, 1929.

The drop-weight method of determining the surface tension of a liquid is discussed with reference to the hanging drop, the detached drop and the detaching drop. The theory of the first has been fairly well worked out, but the information regarding the second is entirely empirical, and little information or even speculation exists with reference to the third. Profiles of hanging and detaching drops taken by motion-picture cameras are reproduced. T. H. P.

440. Surface Properties of Soap Solutions. W. C. Preston and A. S. Richardson. *J. Phys. Chem.* 33. *pp.* 1142–1150, *Aug.*, 1929.

Measurements of the surface viscosity, surface tension and foaming power were made simultaneously on soap solutions of several distinctive types, before and after prolonged exposure to air. No simple correlation of these properties was obtained. The soap solutions showed a low surface tension, but this alone did not involve tendency to foam. Low surface tension and high surface viscosity or plasticity did not confer high foaming power upon the solution. Solutions exhibiting a high foaming power sometimes had a viscosity no greater than that of water. It was concluded that other factors, as yet unknown, determine the foaming power of soap solutions. F. J. B.

441. Measurement of Viscosity of Glass at High Temperatures by the Rotating Cylinder Viscometer. R. F. Proctor and R. W. Douglas. *Phys. Soc., Proc.* 41. *pp.* 500–516; *Disc.*, 516–519, *Aug.* 15, 1929.

After reviewing previous work on the subject the paper describes an apparatus in which the molten glass is contained in a cylindrical sillimanite pot provided with a coaxial cylindrical stirrer which is caused to rotate: the viscosity is inferred from the angular velocity produced in the stirrer by a measured torque. The apparatus was calibrated by measurement with it of the viscosities of golden syrup and pitch, these quantities being also measured independently with a falling sphere viscometer and by a torsion method respectively. The calibration factor of the authors' apparatus appears to be independent of the viscosity over a wide range. The authors' results and those of previous workers are considered to be in reasonable agreement with one another when allowance is made for differences in composition of the samples used. AUTHORS.

442. Structural Viscosity of Aqueous Solutions of Sulphonated Oils. W. Schindler and E. Flaschner. *Kolloid Zeits.* 48. *pp.* 328–338, *Aug.*, 1929.

Measurements are made with the overflow viscosimeter of Ostwald and Auerbach at 20° to 22° C. under addition of ammonia, caustic soda or toluene to the oil. At *p*H values above 7·8 or 8 castor-oil solutions may show considerable structural viscosity, but only above certain concentrations, and the values vary much with the mode of preparation of the oil. At *p*H greater than 10 this viscosity is less marked. Structural turbulence is also observed, as in ammonium oleates. Emulsion of castor oil with toluene shows the same properties to a lesser degree. That applies also to sulphonated train oil, within narrower limits. H. B.

443. Molecular Forces from the Viscosity of a Gas. H. R. Hassé and W. R. Cook. *Roy. Soc., Proc.* 125. *pp.* 196–221, *Aug.* 1, 1929.

It has been shown by Lennard-Jones that the equation of state can be deduced in the case of a molecular model for which the repulsive force between two molecules is of the form λr^{-n} and the attractive force of the form μr^{-m}. In the first part of the present paper the formula for the viscosity of a gas is deduced for the case $n = 9$ and $m = 5$. In the second part the results are compared with those obtained by experiment in the cases of argon, hydrogen, nitrogen, air, carbon-dioxide, mercury vapour and neon. F. S.

444. Friction, Thermal Conductivity and Diffusion in Mixtures of Gases. Part I. M. Trautz. *Ann. d. Physik,* 82. 2. *pp.* 227–239, *Jan.* 12, 1927. **Parts II, III and IV. M. Trautz, P. B. Baumann, F. W. Stauf and K. F. Kipphan.** *Ann. d. Physik,* 2. 6. *pp.* 733–748, *Aug.* 26, 1929.

In Part I the author describes a new procedure for deriving the laws of friction, thermal conductivity and diffusion in mixtures of gases, and subscribes a very detailed discussion of the factors involved. Part II deals with the study of friction in mixtures of hydrogen and nitrogen, and of hydrogen and carbon monoxide. The measurements have been made against air as comparison gas by means of the transpiration method. The expectation that the friction of hydrogen mixtures with nitrogen and carbon monoxide show great similarities and that maxima either do not exist at all or only at very low temperatures has been realised, since the isotherm at – 78° is almost horizontal. Part III investigates the friction of hydrogen and ethylene mixtures. It is found that the isotherms in the friction coefficient–molecular friction diagram exhibit a decided maximum which flattens with increasing temperature. The position of the maximum is displaced with rising temperature with good approximation to a straight line, and more so in the mixtures of lower hydrogen content. The latter observation was also made with mixtures of sulphide dioxide and hydrochloric acid gas with hydrogen respectively. The displacement order is hydrochloric acid > ethylene > sulphur dioxide, and this is not in agreement with the critical temperatures. Part IV discusses friction in binary and ternary mixtures of the inert gases measured by viscosimetric analysis alongside density determinations. Very full tables of data are included. H. H. Ho.

445. Magnitude of Gas Bubbles in Liquids. R. Schnurmann. *Zeits. f. phys. Chem.* 143. 5–6. *pp.* 456–474, *Sept.*, 1929.

Air was forced through Berkefeld, glass, porous earthenware and carbon filters, and the magnitude of the bubbles which were formed was observed. The liquids employed were mixtures of alcohols, acids, sugar, urea and certain electrolytes. The bubbles were classified as small, medium and large, according to sizes of less than 1 mm., 1 to 2 mm. or greater than 2 mm. The results showed that the size of the bubbles depended upon the nature of the liquid, but was independent of the nature of the filter. The viscosity of the liquid was the determining factor for the size of the bubbles. F. J. B.

446. Simple Capillary and Gravitational Waves in Flowing Media. Part I. K. Uller. *Zeits. f. angew. Math. u. Mechanik*, 9. *pp.* 305–312, *Aug.*, 1929.

In previous papers a system of hydrodynamic equations was obtained which is now applied to the special cases of purely capillary and gravitational waves respectively. The basic assumptions made are two density stable non-viscous media in liquid or gaseous state, and a wave source free from turbulence. The paper is entirely mathematical, but it is noteworthy that the waves depend on the absolute values of both velocities with respect to the reference system in which the external force field is stationary, and that the pressure field of the waves in the flowing media is not only different from that of the waves in the static media, but also from the direction of the velocity of flow to the wave propagation. The wave is not reversible. H. H. Ho.

447. Additional Resistance in Turbulent Flow through Rough Channels. M. F. Treer. *Phys. Zeits.* 30. *pp.* 539–542, *Sept.* 1, 1929.

This investigation has established that when the different data available are recalculated for the same diameter of tube, a uniform system of additional resistances is given for different degrees of roughness, especially at the higher Reynolds numbers. The greatest influence is found at a certain distance from the boundary, which is a multiple of the magnitude of the boundary unevenness. The additional resistance, like the Reynolds number, appears to alter according to the Ombeck formula. H. H. Ho.

448. Velocity Distribution in Rectilinear Turbulent Flow. M. F. Treer. *Phys. Zeits.* 30. *pp*. 542–551, *Sept* 1., 1929.

The shape of the velocity curve is found to be dependent only on the reduced shearing force, and changes with it whether by change of roughness or Reynolds' number. Considered apart from the neighbourhood of the boundary (1/10th to 1/5th of the wall distance from the maximum velocity), the velocities are given by parabolae which are obtained from the Navier-Stokes equations solely by introduction of increased but constant frictional coefficients. The usual power law holds for the velocity in proximity to the boundary. H. H. Ho.

449. Alternate Vortices of Bénard-Kármán in a Canal of Finite Breadth. L. Rosenhead. *Comptes Rendus*, 189. *pp*. 397–398, *Sept*. 2, 1929.

Points out that Synge's results give the resistance as a difference of two terms, and Villat's result [see Abstract 2345 (1929)] gives, in the limit, the second, and that the two methods give the same result if the vortices are at rest. In a note added, **H. Villat** agrees, but insists that there is still divergence in the limit for the other terms. W. G. B.

450. Poincaré Waves in a Rotating Canal. E. Fichot. *Comptes Rendus*, 189. *pp*. 401–404, *Sept*. 9, 1929.

Examines these waves in detail, and corrects some of Poincaré's too general statements. W. G. B.

451. Integrals of Equations of Motion of a Solid in a Liquid. M. Kourensky. *Comptes Rendus*, 189. *pp*. 477–479, *Sept*. 30, 1929.

Mathematical. Three integrals are known. A fourth would reduce the problem to a quadrature. Possible fourth integrals, of the first and second degree, are discussed, but it is difficult to show that the equations for the determination of the coefficients are independent, or that the integral, when found, is independent of the other three. W. G. B.

452. Certain Stationary Plane Motions of Viscous Incompressible Liquids. A. Rosenblatt. *Comptes Rendus*, 189. *pp*. 450–452, *Sept*. 23, 1929.

The case solved is that of two liquids in contact, with no relative motion along the line of contact. W. G. B.

453. Hot Wire Method for Determining the Longitudinal Spacing of Vortices. E. Tyler. *Journ. Sci. Instruments*, 6. *pp*. 310–314, *Oct*., 1929.

The paper describes a method of measuring the longitudinal spacing (l) of vortices formed behind a stationary cylinder placed in an air stream. It is based upon the fact that the velocity fluctuations at two points in a vortex row are in phase when the longitudinal distance between the points is equal to the distance between successive vortices in the same row, or a multiple of this distance. By employing two electrically-heated platinum wires, coupled to a vibration galvanometer, previously tuned to the frequency of formation of the vortices, and each wire suitably placed, one in each vortex row, these points have been located differentially.

Results for the lateral spacing (h) of the vortex rows are also included, and the values of h/l obtained are in good agreement with theory. AUTHOR.

454. Empirical Formula Giving the Distribution of Velocity over a Circular Orifice. R. Mazet. *Comptes Rendus*, 189. *pp.* 452–455, *Sept.* 23, 1929.

After outlining a method for the exact solution of this problem, analytically formidable, one of the series is replaced by two terms, and the formula for the normal velocity at distance r from the centre of a hole of radius a is found as $0 \cdot 63\sqrt{2gh} \, . \, (1 + 2s^2)\sqrt{1 - s}$, where $s = r^2/a^2$. This gives good agreement with the experimentally determined coefficient of discharge, and the pressure distribution over the orifice. W. G. B.

455. High Vacuum Technique—Effect of Ionisation on Pump Speeds. C. T. Knipp and P. C. Ludolph. *J.O.S.A. and R.S.I.* 19. *pp.* 152–157, *Sept.*, 1929.

The pump speed s, using Gaede's definition, is investigated for four types of mercury-vapour diffusion pumps. For single-stage and two-stage pumps $s_{\max.}$ is generally lower, and is reached at lower pressures, the higher the backing pressure. A two-stage, internally water-cooled pump, fitted with electrodes (50,000 volts d.c.) on the high and low vacuum sides, is found to possess a greater speed than the normal (at pressures exceeding 0·01 mm.) when the discharge opposes the air stream and a lower speed when the polarity of the electrodes is reversed. The effect is attributed mainly to the electron stream, positive ions being numerous only in the neighbourhood of the kathode. L. V. C.

456. Superposition Law of a Finite Deformed Elastic Continuum Capable of Relaxation and Derivation of Equations in the Euler Form for a Viscous Liquid. H. Hencky. *Ann. d. Physik*, 2. 6. *pp.* 617–630, *Aug.* 26, 1929.

In this paper a (in general) non-linear superposition law is derived from the extension law of an ideal elastic substance. By means of an hypothesis, based on the relaxation in the Maxwell sense, the fundamental equations for viscous fluid motion have been derived from the finite changes of form of an originally elastic continuum. It is shown that the Navier-Stokes equations of hydrodynamics are given as a special case for an infinitely great thrust modulus and an infinitesimal relaxation period, whereby the product of both quantities remains finite, but that with the inhomogeneous current states of actual liquids this condition must fail with great velocities. H. H. Ho.

457. Stability of an Annulus. A. Lokchine. *Comptes Rendus*, 189. *pp.* 316–317, *Aug.* 12, 1929.

This mathematical paper investigates the effect of forces uniformly distributed on the exterior boundary of a plate included within two concentric circles, which are normal to the contour and act upon the plane intermediary surface. By increasing the pressure, an expression is obtained for the critical value at which flexure commences. H. H. Ho.

458. Average Force Exercised by the Stationary Vibration of a Cord Passing Through a Ring. M. Takeuchi. *Comptes Rendus*, 189. *pp.* 459–460, *Sept.* 23, 1929.

The mathematical problem now considered is that of a vibrating cord attached to a fixed point which passes through a ring capable of displacement along the cord, its position constituting a bond. The average force exercised by the stationary vibration, although previously obtained by Rayleigh, is now calculated by a very elementary method. The average lateral force is zero, and the ring when free to move is displaced along the cord. H. H. Ho.

459. Stretching and Expansion of Caoutchouc Films Above the Critical Shear Temperature. M. Kröger and W. N. Yao. *Zeits. f. Elektrochem.* 35. *pp.* 358–362, *June*, 1929.

It is shown that the free blowing out of membranes substantially to spheres represents a particularly advantageous deformation. This deformation represents greater power. The energy taken in on the free development into a sphere is of the same magnitude as on linear expansion (5 mkg. per cm.^{3}) In spite of variations in exterior deformations the deformations due to shear molecular processes are the same. This is also shown to be the case by optical relationships. The investigation of shear with temperature gave a critical shear temperature. Compounding ingredients displace this to higher temperatures. J. K.

460. Regain of Stretched Fibres and Porous Structure of Wool. A. T. King. *Faraday Soc., Trans.* 25. *pp.* 451–458, *Aug.*, 1929.

The investigations of various workers are reviewed, reference being made to the work of Travers, Katz, Linebarger, Williams, Hedges and Fisher. The object of the present work is to establish qualitatively the changes in regain, particularly of the actual elongation and the degree of permanence of the altered regain. It is observed that microscopic examination of stretched fibres showed evidence, after removal of the scales, of elongation of the visible pores. Fibres steamed in stretched condition (permanently set) showed evidence of a sealing and disappearance of the pores. J. K.

461. Extension and Period of a Conically-Wound Spring. O. B. Ader. *Phys. Rev.* 34. *pp.* 656–659, *Aug.* 15, 1929.

By imposing certain restrictions on the shape of a conically-wound spring, it is valid to assume that the extension under a load is due entirely to torsion. It is found that the extension is then given to an approximation by the expression: $Z = \frac{2MgR^2L}{3\pi n r_1^4}$, where M$g$ is the load, R is the radius of the end coil, L and r_1 are respectively the length and radius of the wire of which the spring is made, and n is its rigidity modulus. For a truncated, conically-wound spring, this expression becomes: $Z = \frac{2MgN(R+r)(R^2+Rr+r^2)}{3nr_1^4}$, N being the number of coils of the spring, and r the radius of the small end coil. By making certain assumptions the period is shown to be: $T = 2\pi\left[\left(1+\frac{xm}{M}\right)\frac{z}{g}\right]^{\frac{1}{2}}$, in which m is the mass of the spring, and X is a function of the ratio of the radii of the two end coils. AUTHOR.

462. Experimental Study of Deformation of a Plane Spiral. G. P. Arcay. *Comptes Rendus*, 189. *pp.* 479–481, *Sept.* 30, 1929.

Describes experiments in which the form of a clock hair-spring was determined by cinematography while the balance wheel was oscillating, and the form of the static deflections also photographed. Comparison showed that, to the order of experimental accuracy (1/100th mm.), there was no difference between kinetic and static displacements. W. G. B.

463. Compressibilities and Thermal Pressure Coefficients of Certain Liquids. H. Hildebrand. *Phys. Rev.* 34. *pp.* 649–651, *Aug.* 15, 1929.

Values for the compressibilities of heptane, acetone, carbon tetrachloride, benzene, carbon disulphide, ethylene chloride, ethylene bromide and bromoform, obtained by Westwater, Frantz and Hildebrand from their direct measurements of the thermal pressure coefficient, $(\partial p/\partial T)_v$, were subjected to a small error which is here corrected. The corrected values are compared with some recalculated from the adiabatic compressibilities directly measured in 1913 by Tyrer, and obtained recently by Freyer, Hubbard and Andrews by the aid of a sonic interferometer. The data from the three sources and methods show excellent agreement. Values are given for the constant $v^2T(\partial p/\partial T)_v$, from which can be calculated the coefficients of thermal pressure or of compressibility at various temperatures by the aid of existing data for the densities and coefficients of expansion. In the following list the first number for each substance represents the coefficient of thermal pressure at 20°, the second the compressibility at $20° \times 10^7$ and the third the value of the above-mentioned constant: heptane, 8·66, 1430, 5420; acetone, 11·32, 1260, 5305; carbon tetrachloride, 11·47, 1060, 1325; benzene, 12·58, 966, 4800; carbon disulphide, 12·67, 938, 2340; ethylene bromide, 15·20, 633, 936; ethylene chloride, 14·17, 818, 2640; bromoform, 15·32, 594, 537. The unit of pressure is the atmosphere, v is the specific volume. AUTHOR.

464. Method of Evaluating the Kinematic Coefficients of Linked Systems. T. Smith. *Phys. Soc., Proc.* 41. *pp.* 576–584, *Aug.* 15, 1929.

The coefficients in a function representing the energy of a system, or any function having analogous properties, may be combined to form a matrix such that the matrix of the combination of any number of systems is the product of the matrices of its parts. AUTHOR.

465. Simple Examples of Adiabatic Invariance. W. B. Morton. *Phil. Mag.* 8. *pp.* 186–194, *Aug.*, 1929.

The principle of adiabatic invariance of periodic systems plays an important part in the modern dynamics of the atom. In its simplest form, as applied to systems of one degree of freedom, it states that the action through a period remains the same when secular changes take place in the physical characteristics of the system. In the present mathematical note three cases are treated: (1) A simple pendulum swinging through an arc of any extent and passing into complete revolutions. The bob is supposed to be constrained to move on the circle, so that in cases in which the string would become slack it is replaced by a weightless rod. Alternatively the particle may be supposed to move in a smooth circular tube, or as a bead on a wire, the tube or wire contracting slowly. (2) A simple oscillator. (3) A particle describing a planetary orbit. In each case the slow changes are taken to affect all the magnitudes which enter as constants in the problem. H. H. Ho.

466. Application of Stieltjes Integrals to the Problem of Neumann. M. Gunther. *Comptes Rendus*, 189. *pp.* 447–450, *Sept.* 23, 1929.

Mathematical. The use of the Stieltjes integral is advocated for analytic reasons. W. G. B.

467. Method of Producing Long Single Crystals of Metal and a Study of the Factors Influencing Crystal Orientation and Perfection. A. Goetz and M. F. Hasler. *Nat. Acad. Sci., Proc.* 15. *pp.* 646–656, *Aug.*, 1929.

Melted bismuth, the surface of which was reduced in an atmosphere of hydrogen in an electric furnace, was drawn into a soda glass tube the softening temperature of which was a little above the melting point of bismuth. To avoid gas bubbles the interior of the tube was cleaned with hot chromic acid, distilled water and alcohol. When the bismuth had crystallised into a monocrystal the tube was placed in an apparatus which fed it slowly into an electric furnace, while it was drawn out from the other end of the furnace three times as fast, so as to make it longer and narrower; the melted bismuth crystallised again into a monocrystal outside the furnace, and the glass was removed with hydrofluoric acid. The effect of the temperature gradient at the point of solidification on the orientation of the crystal was studied, and though no strict relation was found it was evident that variation of the gradient in general caused a variation of the orientation. It appears, however, that the orientation of the gradient is not the only factor concerned; the strain applied by the glass walls due to the expansion of the metal at the melting point and subsequent contraction during cooling seems to be of importance.

H. N. A.

468. Theory of Isomorphous Growth of Ionic Crystals on One Another. I. N. Stranski. *Zeits. f. phys. Chem.* 142. 6. *pp.* 453–466, *Aug.*, 1929.

A method is given for calculating the degree of supersaturation at which an ionic crystal is deposited from solution on an isomorphous ionic crystal in the case when both crystals belong to the simple type AB and differ only as regards the charges of the constituent ions. The assumption is made that, as with the growth of the pure crystals, the foreign ions attach themselves mainly at those places on the surface of the foundation crystals for which the work of separation is greatest. In order that sodium bromide may be deposited from aqueous solution on to crystals of galenite, supersaturation amounting to 3 % is calculated to be necessary. The major part of the difference in the work of separation is attributable to the deformation of the ions. In connection with the influence of deformation, the system calcspar-sodium nitrate solution is investigated. If only the electrostatic factor were of importance in calculating the supersaturation, sodium nitrate should deposit on a calcspar crystal without supersaturation, but this is not the case. The formation of mixed crystals from two such crystals is considered in relation to the fact that crystals of the type AB consisting of doubly (and more highly) charged ions separate from solution only as extremely small individuals. [See also next Abstract.]

T. H. P.

469. Isomorphous Growth of Ionic Crystals on One Another. I. N. Stranski and K. Kuleliew. *Zeits. f. phys. Chem.* 142. 6. *pp.* 467–475, *Aug.*, 1929.

Results are given of experiments made to ascertain how far the supersaturation at which an ionic crystal is deposited from solution on an isomorphous ionic crystal differing only as regards the charges on the constituent ions is determined by the two crystals, by the environment

(solvent) and by the temperature. The systems examined consisted of aqueous sodium nitrate solution with calcspar (or siderite or rhodochrosite) and of aqueous sodium bromide solution with galenite. Reproducible results are obtained, and the supersaturation appears to be determined by the system and temperature. For rhodochrosite the supersaturation is always slightly greater than for siderite. By the method of Volmer and Weber [see Abstract 1682 (1926)] no deposition of sodium bromide on galenite could be obtained, since the supersaturation above 50·7° C. is too low. On calcspar, siderite and rhodochrosite, sodium nitrate is deposited in an orientated state, and, in all cases, first at the angles and then at the edges of the rhombohedron; deposition on the middle portions of the faces is always accompanied by unevenness. From the mode of deposition of sodium nitrate on these three crystals it is evident that the growth of ionic crystals of this type follows a course analogous to that observed with sodium chloride crystals. [See also preceding Abstract.]
T. H. P.

470. Structure of Dimethyl Diethyl Ammonium Chlorostannate. R. W. G. Wyckoff and R. B. Corey. *Am. J. Sci.* 18. *pp.* 138–144, *Aug.*, 1929.

From X-ray, Laue and oscillation photographs it is deduced that the unit tetragonal cell contains two molecules of $[N(CH_3)_2(C_2H_5)_2]_2$ Sn Cl_6 and has dimensions $a = 9 \cdot 06$ Å. and $c = 14 \cdot 12$ Å. The reflections fulfil the demands of the space-group 4Di–6, and the position of the tin and chlorine atoms are fixed. The structure as a whole is probably a distorted CaF_2 [or $(NH_4)_2$ Sn Cl_6] arrangement having a symmetry and space-group less than holohedral.
W. H. Ge.

471. Crystal Structure of Tricalcium Aluminate. F. A. Steele and W. P. Davey. *Am. Chem. Soc., J.* 51. *pp.* 2283–2293, *Aug.*, 1929.

The product obtained by heating $3CaO + Al_2O_3$ contains, in addition to tricalcium aluminate, free lime and $3CaO . 5Al_2O_3$, from both of which it is substantially separated by means of its higher specific gravity (approximately 3·0). Crystals being unobtainable, examination was by the powder method. Very full details are given as to how the three probable structures—all body-centred cubic—were selected from some 1500 possibilities. The unit cell is a cube, $a = 7 \cdot 624$ Å., containing $9CaO . 3Al_2O_3$. A diagram of the most probable structure is given. This is mixed ionic, the entire structure being built up of Ca, Al and O ions as units, with no indication of the presence of any groups such as CaO, Al_2O_3, etc.
C. A. S.

472. Crystal Structure of Andalusite. W. H. Taylor. *Zeits. f. Krist.* 71. 3. *pp.* 205–218, *Aug.*, 1929. *In English.*

From rotation X-ray photographs and ionisation spectrometer measurements it is deduced that the orthorhombic unit cell of andalusite has dimensions $a = 7 \cdot 76 \pm 0 \cdot 03$ Å., $b = 7 \cdot 90 \pm 0 \cdot 03$ Å., and $c = 5 \cdot 56 \pm 0 \cdot 02$ Å. (density 3·1–3·2), contains 4 molecules of Al_2SiO_5, and has the symmetry of the space-group V_h^{12}. From qualitative intensity measurements the atomic arrangements are determined and discussed in relation to those of cyanite and sillimanite. It is shown that an aluminium atom may be surrounded by six, *five* or four oxygen atoms in crystals.
W. H. Ge.

473. Secondary Liquid Inclusions in Minerals. G. Laemmlein. *Zeits. f. Krist.* 71. 3. *pp.* 237–256, *Aug.*, 1929.

A review of previous work and a very comprehensive Bibliography of the subject are given. The experimental work contains the preparation of secondary liquid inclusions similar to those observed in natural crystals. It is concluded that the formation of the secondary liquid and gaseous inclusions is the result of a dendritic-like healing of crystal cracks, and appears to be a general phenomenon in a whole series of minerals. The present investigation of secondary inclusions has led to a study of the formation of crystal cracks and fissures and to the growth of skeleton crystals. Attempts to determine the thermodynamic conditions of crystal formation based on the data of secondary inclusions require a knowledge of the difference in character between primary and secondary inclusions. For further progress in the study of minerogenesis it is necessary to correlate liquid inclusions with other secondary phenomena such as etching and weathering. H. H. Ho.

474. Space-Group of Antimonite Sb_2S_3. C. Gottfried and E. Lubberger. *Zeits. f. Krist.* 71. 3. *pp.* 257–262, *Aug.*, 1929.

By means of the Weissenberg Röntgen goniometer the space group $D_{2h}p\beta\nu\mu(V_h^{16})$ has been accurately determined for antimonite, whose crystal data are $a = 11 \cdot 39$, $b = 11 \cdot 48$, and $c = 3 \cdot 89$ Å. It is established that the crystal element contains 4 molecules Sb_2S_3. H. H. Ho.

475. Structure Determination of Three Organic Substances. A. Burgeni, F. Halla and O. Kratky. *Zeits. f. Krist.* 71. 3. *pp.* 263–268, *Aug.*, 1929.

This paper contains a complete crystallographic examination of the following organic substances: *d*-tyrosinchlorhydrate (hydrochloride of the β-oxyphenyl-α-amino-propionic acid)

$$OH.C_6H_4.CH_2.CH.(NH_2.HCl).COOH;$$

tetramethyl ester of methane tetracarbonic acid (Scholl's ester) $C.(COOCH_3)_4$; and *o*-toluene-sulphonamide, $CH_3–C_6H_4–SO_2.NH_2$. H. H. Ho.

476. Fine Structure of Gypsum. E. Onorato. *Zeits. f. Krist.* 71. 4. *pp.* 277–325, 1929.

The unit cell of gypsum is a face-centred parallelepiped containing four molecules of $CaSO_4.2H_2O$. The sulphur atom is situated at the centre of a tetrahedron, at the apices of which are the four oxygen atoms of the sulphate group. Each calcium atom lies between four sulphate tetrahedra. The water molecules lie on either side of the calcium atom on an axis which is perpendicular to the (010) plane and passes through the calcium atom. In agreement with Werner's theory the chemical formula of gypsum must be written $(Ca.2H_2O)SO_4$. The relation between gypsum and the corresponding hemi-hydrate and anhydrous calcium sulphate is discussed. F. J. W.

477. Morphology and Optical Properties of Brookite. W. Arnold. *Zeits. f. Krist.* 71. 4. *pp.* 344–405, 1929.

Measurements on crystal angles by the goniometer of Gold gave the possible forms of which many were actually observed with the samples from the Maderanertal, Switzerland. In accord with other observers, it appears that the brookites can be classified in three groups. The characteristics of the known varieties are tabulated with the idea of determining the relative frequencies of the various forms. Measurements of angles between the optic axes for various wave-lengths and temperatures gave values which represent the mean of existing data. The spectral distribution of absorption and the double refraction were also studied. A very complete list of references is given at the end of the paper. J. E.

478. Theory of Gliding, Translation and Twinning in Crystals. Geometrical Analysis. P. Niggli. *Zeits. f. Krist.* 71. 5–6. *pp.* 413–451, 1929.

A theoretical deduction of the geometrical conditions for crystal slip under applied stress leading to translation and twinning, and the relations between these gliding processes. A. J. M.

479. Rules of Selection for Crystal Structure in Tetragonal Space Systems. E. Brandenberger. *Zeits. f. Krist.* 71. 5–6. *pp.* 452–500, 1929.

A tabulation of analytical expressions of the criteria for space groups in the tetragonal systems. A. J. M.

480. Crystal Structure of Potassium Chlorate. W. H. Zachariasen. *Zeits. f. Krist.* 71. 5–6. *pp.* 501–516, 1929. *In English.*

The structure has been determined by the method of absolute intensities [see W. L. Bragg and J. West, *Zeits. f. Krist.* 69. *p.* 118, 1928], and a Fourier analysis of the electron distribution projected on the 010 plane. The symmetry is monoclinic holohedral, and the unit cell, containing two molecules, has dimensions $a = 4\cdot647 \pm 0\cdot004$ Å., $b = 5\cdot585 \pm 0\cdot005$ Å., $c = 7\cdot085 \pm 0\cdot007$Å., $\beta = 109° 38' \pm 5'$. Space group C_{2h}^2. 2K, 2Cl and 2O are in positions $(u0v)$, $(\bar{u}\tfrac{1}{2}\bar{v})$, with respective parameters u_1v_1, u_2v_2, u_3v_3; 4O in (xyz), $(x\bar{y}z)$, $(\bar{x}\,y+\tfrac{1}{2}\,\bar{z})$, $(\bar{x}\,\tfrac{1}{2}-y\,\bar{z})$, where $u_1 = 0\cdot366$, $u_2 = 0\cdot106$, $u_3 = 0\cdot405$, $v_1 = -0\cdot298$, $v_2 = 0\cdot175$, $v_3 = 0\cdot111$, $x = 0\cdot139$, $y = 0\cdot222$, $z = 0\cdot278$. Each atom of potassium is surrounded by 9 oxygen atoms at an average distance of 2·94 Å. Three oxygen atoms are unsymmetrically situated around each chlorine atom forming a ClO_3 group in which Cl–O = 1·48 Å. and O–O = 2·38 Å. Δ (the displacement of Cl out of the O_3 plane) = 0·50 Å. The connection between the structure and the optical and other properties and the similarity to calcite are shown. C. A. S.

481. Crystal Structure of Sodium Chlorate. W. H. Zachariasen. *Zeits. f. Krist.* 71. 5–6. *pp.* 517–529, 1929. *In English.*

The method followed is given above [see preceding Abstract]. The symmetry is cubic tetartohedral, the unit cube ($a = 6\cdot570 \pm 0\cdot006$ Å.) contains four molecules. Space group T^4. 4Na are in positions $4f$ with parameter u, 4Cl in $4f$ with parameter v, and 12O in general positions with parameters xyz, where $u = 0\cdot064$, $v = 0\cdot417$, $x = 0\cdot303$, $y = 0\cdot592$, $z = 0\cdot500$. Each sodium atom is surrounded by 6 oxygen atoms forming a distorted octahedron, mean distance Na–O = 2·46 Å. In the ClO_3 group each Cl is surrounded by 3 O-atoms forming an equilateral triangle, Cl–O = 1·48 Å., O–O = 2·38 Å. Δ (the displacement of Cl out of the O_3 plane) = 0·48 Å. Thus the structure of the ClO_3 group is the same as in potassium chlorate. C. A. S.

482. Crystal Structure of Chlorides of Certain Bivalent Elements. L. Pauling. *Nat. Acad. Sci., Proc.* 15. *pp.* 709–712, *Sept.*, 1929.

It is shown that the unit of structure of $CdCl_2$ is a rhombohedron with $\alpha = 36° 40'$ and $a = 6\cdot35$ Å., containing 1 $CdCl_2$, Cd at 000, 2 Cl at uuu, $\overline{uuu}$, with $u = \frac{1}{4}$. The isomorphous crystals $MgCl_2$, $CoCl_2$, $NiCl_2$ have $\alpha = 33° 36'$ and $a = 6\cdot21$, $6\cdot14$ and $6\cdot13$ Å. respectively. Other representatives of the structure are $MnCl_2$, $ZnCl_2$, $RuCl_2$, $RhCl_2$, $PdCl_2$, $IrCl_2$ and $PtCl_2$. A. J. M.

483. Polymorphism of Sodium Sulphate. Part I. Thermal Analysis. F. C. Kracek. *J. Phys. Chem.* 33. *pp.* 1281–1303, *Sept.*, 1929.

Points out that it has long been known that anhydrous sodium sulphate inverts at about 234° C. The author notes that results of optical studies and of thermal analysis are not in agreement. It is shown that the temperature 234° C. is based on the principal arrest obtained with cooling curves, this being only one of several arrests. Optical examinations confirms the existence also of several forms. It is concluded that Na_2SO_4 can exist in five distinct modifications. Owing to hysteresis in the inversions, however, the equilibrium temperatures cannot be fixed. J. K.

484. Polymorphism of Sodium Sulphate. Part II. Densities of Anhydrous Sodium Sulphate at 25°. F. C. Kracek and R. E. Gibson. *J. Phys. Chem.* 34. *pp.* 1304–1308, *Sept.*, 1929.

The results show that Na_2SO_4 can exist at ordinary temperatures in at least two modifications, thenardite, Na_2SO_4, with a density of $2\cdot664 + 0\cdot001$, and another modification, Na_2SO_4III, having a density of $2\cdot697 + 0\cdot001$. The volume change accompanying the mutual conversion is $0\cdot0045$ cm³./gm., or $1\cdot2$ % of the volume of Na_2SO_4V at 25°. It is stated that these results are in agreement with reliable data, both optical and on densities, published by other workers. J. K.

485. Crystal Structure of Tysonite and of Artificially Prepared Fluorides of the Lanthanum Group. I. Oftedal. *Zeits. f. phys. Chem.* 5. *Abt. B.* 3–4. *pp.* 272–291, *Sept.*, 1929.

Continuing the work of Goldschmidt, Hougen and Lunde, measurements have been made on the trifluorides of La, Ce, Pr, Nd and Sm, and on tysonite, a mineral consisting mainly of CeF_3, with some LaF_3 and the other fluorides of the above list. Powder photographs indicate that there are two molecules in the elementary cells, the dimensions diminishing as the atomic number increases. The dimensions of the cell are given in the following table:

	c.	Δc.	a.	Δa.	c/a.	Density.
57. La	7·329		4·135		1·772	5·99
		0·056		0·028		
58. Ce	7·273		4·107		1·771	6·16
		0·055		0·030		
59. Pr	7·218		4·077		1·771	6·33
		0·022		0·024		
60. Nd	7·196		4·053		1·775	6·52
61. —	—	0·046	—	0·023	—	—
62. Sm	7·15		4·03		1·773	6·83

Since the atomic weight of fluorine is small compared with those of these elements, no lines due to the fluorine lattice are observed in the powder X-ray photographs, though the intensities of the lines due to the heavy atoms are modified by the fluorine atoms. Further information is obtained from a Laue photograph taken with tysonite, which has the same structure as the other fluorides. This shows that the complete elementary cell is three times as large as that given above, and contains six molecules. The value of *a* for lanthanum is really 7·163 Å., with corresponding values for the other elements. The space group in all cases is D_6^6, and the positions of all the atoms are defined and shown in a diagram. H. N. A.

486. Dependence on Temperature of Critical Tension of Cadmium Crystals. W. Boas and E. Schmid. *Zeits. f. Physik*, 57. 9–10. *pp.* 575–581, 1929.

The commencement of plastic deformation of cadmium crystals has been investigated in the region from 20° K. to the melting point. The critical stresses of the translation systems decrease linearly at first with rising temperature, but remain constant from about 140° up to the melting point. Examples are given of the curves obtained for these crystals, and the results are tabulated. It is shown that the temperature dependence of s_{44} is much too small to explain the observed temperature dependence of the critical tension on the basis of a constant critical force. [See Abstract 2087 (1929).] R. S. R.

487. Stability of Submicrons. Solution and Formation of Crystals. J. Traube. *Zeits. f. Elektrochem.* 35. *p.* 626; *Disc.*, 627, *Sept.*, 1929. *Paper read before the Deut. Bunsen Gessell., Berlin, May*, 1929.

A summary of the researches of Traube, Behren and other collaborators [see Abstract 680 (1929)] which have been confirmed by Siedentopf's photographic studies. In the *Discussion*, **Smekal** pointed out that the observations could not directly be applied to real crystals. If one did not start from pure single crystals, the phenomena were locally disturbed by the many crystallisation germs, and it was doubtful whether the macrocrystals of Traube could be regarded as single crystals. Those disturbances were trivial, but could not be excluded in the dissolution either; the "lattice bricks" of his (Smekal's) were much smaller than Traube's submicrons and invisible even in the ultramicroscope. The disintegrations of dissolving ionic crystals were, however, in accord with experiments by himself and Quittner [see Abstract 2933 (1929)]. H. B.

488. Compressibility of Crystals. R. F. Mehl and R. H. Canfield. *Nature*, 124. *pp.* 478–479, *Sept.* 28, 1929.

The suggestion by Raschevsky, that experimentally determined values for compressibility coefficients are much greater than the true coefficients on account of internal submicroscopic cracks, is disproved by internal evidence from the relationships of the generally accepted compressibility coefficients among themselves and with other physical properties, and consideration of the possible volume of internal voids. The periodicity of the compressibility coefficients for the elements follows very closely that of such properties as atomic volume, heat of formation of oxides and chlorides, and absolute melting points, which are unaffected by internal voids. The lattice constants calculated from density measurements agree closely with those measured directly by X-ray diffraction, indicating the absence of cracks. A. J. M.

489. Significance of X-Ray Analysis of Alkali Sulphates. A. E. H. Tutton. *Phil. Mag.* 8. *pp.* 195–201, *Aug.*, 1929.

On a basis of work already published, the close correspondence between the results deduced from crystallographic and from X-ray determinations of the structure and dimensions of the space-lattice cells of the alkali sulphates is emphasised. It is also concluded that the space group is more probably V_h^{16} than V_h^{13}. From these and other similar results it is deduced that all morphological and physical properties of crystals of one strictly comparable series of eutropically isomorphous compounds are functions of the atomic numbers and weights of the elements of the group concerned. The progressive change in dimensions points clearly to a regular increase in size of the atom as the number of completed electron shells increases. The apparent exception of the alkali halides is due to structural differences. Confirmation is further afforded by the invariability of the crystal angles of the series $R_2(SO_4 . C_2H_5)_6 . 18H_2O$, where R is a metal of the rare earths, as in this group the addition of electrons occurs in an interior and not in the exterior shell, thus causing practically no change in size of the atom. C. A. S.

490. X-Ray Analysis of Iron-Boron System. T. Bjurström and H. Arnfelt. *Zeits. f. phys. Chem.* 4. *Abt. B.* 6. *pp.* 469–474, *Aug.*, 1929.

A preliminary X-ray analysis of the iron-boron system has been made, and it has been found that from 0 to 19 % boron the compounds Fe_2B and FeB occur. The first of these has a body-centred, tetragonal lattice as found by Wever, the unit cell having $a_1 = 5 \cdot 099$ Å. and $a_3 = 4 \cdot 240$ Å. The unit cell contains 4 molecules Fe_2B. The phase FeB has a rhombohedral lattice defined by the parameters $a_1 = 5 \cdot 495$ Å., $a_2 = 4 \cdot 053$ Å. and $a_3 = 2 \cdot 946$. The unit cell contains four groups of FeB. W. V. M.

491. X-Ray Investigations of Optical Isomers. G. L. Clark and G. R. Yohe. *Am. Chem. Soc., J.* 51. *pp.* 2796–2807, *Sept.*, 1929.

An X-ray examination by the rotation and powder diffraction methods has been made of the *d*-, *l*- and racemic forms of phenylaminoacetic acid. The power of the rotation method is shown by the fact that a straightforward crystal structure analysis was possible although no crystallographic or optical data were available. The *d*- and *l*- forms are shown to crystallise in the orthorhombic system, upon Bravais lattice Γ_0, space group C_{2v}^5. The unit cell containing four molecules has the dimensions $a = 15 \cdot 2$, $b = 5 \cdot 05$, $c = 9 \cdot 66$ Å. The fact that space group C_{2v}^5 admits of no molecular symmetry confirms the classical theories of van't Hoff and Le Bel connecting molecular asymmetry with optical activity. It has not been found possible to distinguish between the *d*- and *l*- forms by means of X-ray diffraction methods. [See also Abstract 1038 (1923).] The crystal form of the racemic modification differs from that of the optically active forms. AUTHORS.

492. X-Ray Observations on Cellulose. Lattice of Cellulose Hydrate. A. Burgeni and O. Kratky. *Zeits. f. phys. Chem.* 4. *Abt. B.* 6. *pp.* 401–430, *Aug.*, 1929.

A more accurate X-ray analysis of cellulose hydrate has been made possible by the use of films of very high orientation prepared from cellulose xanthate. The solution of the following problems has been attempted: the determination of (*a*) the statistical symmetry of the crystalline aggregates; (*b*) the crystalline arrangement, *i.e.*, the position of the translation lattice of the aggregate relative to the macroscopic form of the film; and (*c*) the translation group of the single crystal. The statistical symmetry of the hydrate film is the same as that of the xanthate, rhombic holohedral (anisotropic class 4). The crystalline arrangement could not be determined accurately. To a first approximation, it may be described as the mirror twinning of two monoclinic crystals about the plane of the film. The plane A_0 makes an angle of between 0° and 15° with the plane of the film. The following approximate data are given for the translation lattice: A_0, A_3 and A_4 are probably unique planes in the lattice. The angle made by A_3 and A_4 is between 20° and 45°. The angle between A_0 and A_3 and A_4 is greater than 45°. The translation lattice has rhombic or monoclinic symmetry. On the basis of a unit cell containing four molecules, the following lattice parameters are deduced: $a = 8\cdot 89$ Å., $b = 8\cdot 04$ Å., $c = 10\cdot 35$ Å., $\alpha = 90°$, $\beta = 90°$, $\gamma = 64° \, 30'$. F. J. W.

493. X-Ray Graphical Method of Determining the Size and Form of Ultramicroscopic Crystalline Particles. M. Laue. *Preuss. Akad. Wiss. Berlin, Ber.* 15. *pp.* 227–228, 1929.

It is observed that this question is of technical as well as theoretical importance. Reference is made to the well-known process of Debye and Scherrer. A formula for characterising interference rings is considered, and the application of such a formula in experimental determinations is noted. [See Abstract 2349 (1929).] J. K.

494. Relative Masses of Proton, Electron and Helium Nucleus. E. E. Witmer. *Nature*, 124. *pp.* 180–181, *Aug.* 3, 1929.

For general physical reasons the square root of mass is probably more fundamental than mass itself. Now the square root of the ratio of the masses of proton and electron equals 43 to a very close approximation. The point of interest about 43 is that it is half the sum of the squares of a well-known sequence in atomic structure, for $43 = 1^2 + 2^2 + 2^2 + 3^2 + 3^2 + 4^2$. It is in fact half the atomic number of the inert gas of highest atomic number, radium emanation. A further relation emphasised is the following: $\frac{m_{\mathrm{He}}}{m_{\mathrm{H}}} = \left(\frac{Z_{\mathrm{He}}}{Z_{\mathrm{H}}}\right)^2 \frac{1}{1+\alpha}$, where α is the fine structure constant. The values of α derived respectively from Aston's data and spectroscopically are 0·00724 and 0·00729, which represents excellent agreement. W. S. S.

495. Reflection of Atoms from Crystals. A. Ellett, H. F. Olson and H. A. Zahl. *Phys. Rev.* 34. *pp.* 493–501, *Aug.* 1, 1929.

Beams of mercury, cadmium and arsenic incident upon clean cleavage surfaces of rock salt give rise to specularly reflected beams. Measurement shows that the velocity of the beam of cadmium atoms reflected from rock salt may be represented by $\lambda = \frac{h}{mv} = 2d\left(2\cdot 26 - \frac{\phi}{\frac{1}{2}mv^2} - \cos^2\theta\right)^{\frac{1}{2}}$. A beam specularly reflected from a first crystal is specularly reflected at a second if incident upon it at the same angle at which reflection from the first took place. If the angles are nearly equal there is still some specular reflection at the second crystal, but the intensity of the specular beam drops off with increasing difference of angles and the incident beam is scattered at random. A beam of cadmium atoms issuing from a boiler at 440° C. and striking a rock-salt crystal at an angle of 45° gives rise to a specular beam containing about 17 % of the incident atoms. The intensity of the beams specularly reflected at 22·5° and 67·5° are in the ratio 1 : 1·38. These facts indicate that associated with motion of translation of uncharged atoms and molecules there is a wave phenomenon of the type postulated by de Broglie. [See also Abstracts 1967 (1928) and 2935 (1929).] AUTHORS.

496. Evaluation and Interpretation of Parachors. S. A. Mumford and J. W. C. Phillips. *Chem. Soc., J. pp.* 2112–2133, *Sept.*, 1929.

Systematic discrepancies in the parachors of fatty acids [see Abstract 1402 (1929)] disappear if the series chosen contain similarly linked compounds, *e.g.*, all *n*-compounds. In this way the parachor for $CH_2 =$ becomes 40 instead of 39 (Sugden), and it becomes necessary in computing the parachors of compounds to take into account not only the atoms present and the presence of single or double bonds, etc., but also the presence of branched-chain and of ring structures. The authors are thereby led to the conception of " strain constants," positive or negative, provisional values for which are worked out by a re-examination of surface tension data for a great range of compounds. These " strain constants " are conceived to arise from electrostatic influences between the atoms and groups in a molecule, and depend therefore upon the relative disposition of these atoms and groups. In treating compounds of elements of variable valency, *e.g.*, S, N, P, the use of " strain constants " may be avoided, though sometimes with discordant results, by assigning different parachors to these elements according to the valency exhibited. Associated, *e.g.*, amino- and hydroxy-, compounds may be brought into line with non-associated compounds by assuming that the volume of a hydrogen atom is not the same when it is linked to carbon, to nitrogen or to oxygen, an assumption justified by other phenomena; and the same may also be applied to the fused salts of alkali metals, formerly anomalous in their behaviour. L. V. C.

497. Direct Measurement of Intensity Distribution of Molecular Rays. J. B. Taylor. *Zeits. f. Physik*, 57. 3–4. *pp.* 242–248, 1929.

According to Langmuir, every alkali atom striking a glowing tungsten wire splits off an electron and becomes a positive ion. When such a wire is placed in the path of a molecular beam of alkali atoms, a stream of positive ions proceeds from the wire whose number per second depends on the number of alkali atoms striking the wire. The experimental study of this method [see also Abstracts 2102 and 2103 (1929)] has established that intensity measurements can easily be carried out with great accuracy. An example is included of measurements of the magnetic decomposition of potassium. H. H. Ho.

498. Synthesis of Elements. G. I. Pokrowski. *Zeits. f. Physik*, 57. 7–8. *pp.* 560–565, 1929.

In the previous parts [see Abstracts 2099 and 2949 (1929)] a mechanism of nuclear construction out of protons is considered, in which it is assumed that in the course of this union energy is emitted when an electron approaches very closely to a proton. It is here shown that the

same mechanism can explain the building up of nuclei out of α-particles. A formula is obtained for the resulting defect in mass, and this is calculated for a number of elements which have even atomic numbers and may be built up of helium nuclei. The values agree well with those of Aston.
H. N. A.

499. Search for Element 87 (Eka-Cæsium) by Positive Ray Analysis. K. T. Bainbridge. *Phys. Rev.* 34. *pp.* 752–762, *Sept.* 1, 1929.

Previous methods are discussed. The limiting capabilities of atomic weight determination, radioactive and physiological methods, and X-ray and spectrum analysis are estimated. The ionisation potential of eka-cæsium is calculated as 4·05 ± 0·05 volts, and the principal series resonance lines as 8720 ± 200 Å., and 7600 ± 200 Å. As the most sensitive means, a mass spectrograph (similar to Dempster's) with tungsten filament heated to 1200° to 1300° K. in the vapour of the material to be tested as a source of positive ions was used. This failed to detect any eka-cæsium in preparations from pollucite and lepidolite deemed certain to contain any there might be together with the other alkali metals. It is concluded that there could not be more thereof than $3 \cdot 5 \times 10^{-7}$ of the cæsium present in the material from pollucite, or than $7 \cdot 5 \times 10^{-6}$ in that from lepidolite. The vapour pressures of the alkali metals as determined by Langmuir and Kingdon [see Abstract 1182 (1925)] by means of the positive ion current thermally produced by a tungsten filament in the vapour are shown to be accurate. The method is now to be tried for the separation of isotopes. C. A. S.

V. 33
1930

500. Dimensions of Diatomic Molecules. J. K. Syrkin. *Zeits. f. phys. Chem.* 5. *Abt. B.* 2. *pp.* 156–159, *Sept.*, 1929.

Diatomic homopolar molecules [see Abstract 282 (1929)] are regarded as rigid quadripoles whose moments may be calculated from the critical data. Also the dimensions of the quadripoles have been calculated from the moments, and are in excellent agreement with the nuclear distances afforded by molecular spectra. H. H. Ho.

501. Structure of Diatomic Molecules. G. Herzberg. *Zeits. f. Physik*, 57. 9–10. *pp.* 601–630, 1929.

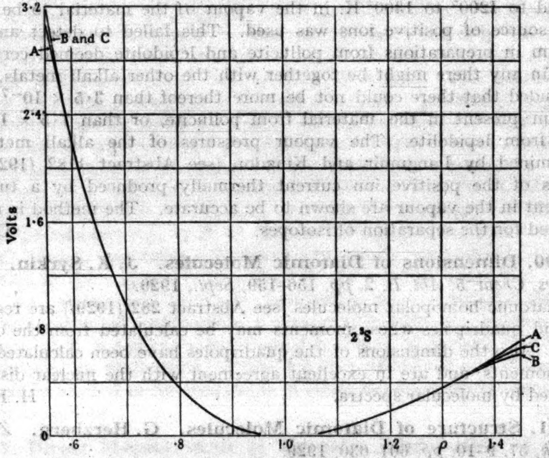
The paper deals principally with the ordering of molecular terms to the terms of the separated atoms. In order to avoid certain divergencies between theory and experiment an extension of the Mulliken–Hund method of molecule building is advanced. It is assumed that in passing from the case of widely separated nuclei to the molecule, the molecular quantum numbers of every electron shall remain the same. In the transition it is only the " energy order " of the different electron shells which varies, and from the way in which this occurs conclusions as to the stability of molecular terms can be drawn. In the new method the Heitler-London-Lewis conception of electron pair bonds can be retained in a generalised form. The theoretical ideas are applied to a series of diatomic molecules for which experimental data are available; the dissociation process and the products of dissociation are particularly discussed. W. S. S.

502. Calculation of Electronic Affinity of Hydrogen. H. Bethe. *Zeits. f. Physik*, 57. 11–12. *pp.* 815–821, 1929.

Previous work, including that of Pauling [see Abstract 1625 (1927)] and Brück [see Abstract 402 (1929)], is first reviewed, following which the electronic affinity of hydrogen is calculated by the Hylleraas method [see Abstract 2936 (1929)] and found to be + 17 k.cal. The electron distributions of H^-, He and Li^+ are compared by which the increase of atomic radius from Li^+ to He and then to H^- is clearly shown. H. H. Ho.

503. Energy Functions of H_2 Molecules. O. W. Richardson and P. M. Davidson. *Roy. Soc., Proc.* 125. *pp.* 23–50, *Aug.* 1, 1929.

If r is the distance between the nuclei of the hydrogen atom in the H_2 molecule, the force between them is expressible as $F = k_1(r - r_0) + k_2(r - r_0)^2 + k_3(r - r_0)^3 + \ldots$, where r_0 is the equilibrium position. It is shown first that the values of k_1, k_2, k_3, deduced from vibrational and rotational spectral data respectively, are in good agreement. Comparison of the values of k_1, k_2 and k_3, deduced for the hydrogen molecules, $2'S$, 2^3S, 3^3P and the HCl molecule show close similarity. The potential energy functions $U(\xi)$ for $2'S$, 2^3S, 3^3P, $3'B$ and H_2+ are derived as numerical expansions of the form $U(\xi) = k\xi^2(1 + a\xi + b\xi^2 + c\xi^3 = d\xi^4 + \ldots)$, where $\xi = \left(\frac{r}{r_0} - 1\right)$ and k, a, b, c, d, are numerical constants. In the accompanying figure U in volts is plotted against $\rho = \frac{r}{r_0}$ for the molecule 2^3S, and similar curves are given in the paper for the other cases mentioned. A number of other important deductions concerning energy relations in hydrogen molecules are included. W. S. S.



504. Recombination of Ions and of Ions and Electrons in Gases. L. C. Marshall. *Phys. Rev.* 34. *pp.* 618–634, *Aug.* 15, 1929.

A study of the recombination of ions, and of ions and electrons, by a new direct method, using constant X-radiation and a rotating commutator shutter. This allows of large variation of the time of X-ray exposure t', the initial ion concentration n_0 and the time of recombination t. The coefficient of recombination α in air was found to be a function of t' and t; it is high for small values of these quantities, and drops rapidly to a nearly constant value as they increase; it is also a function of n_0. This is explained on the assumption that the ions are not initially uniformly distributed. The results support Thomson's theory that diffusion plays the major rôle in the initial stages of the mechanism of recombination. In argon α is not a true measure of the recombination of positive and negative ions, but serves as an indication of the rate of negative ion formation through attachment of electrons to impurities present. H. N. A.

505. Effective Area and Molecular Structure of the Isosteric Series, N_2 – $(CH)_2$ and O_2 – $[(NH)_2]$ – $(CH_2)_2$. E. Brüche. *Ann. d. Physik*, 2. 8. *pp*. 909–932, *Sept*. 15, 1929.

With the help of the magnetic apparatus previously used [see Abstract 34 (1928) and 1777 (1929)] the effective area curves for acetylene and ethylene have been determined. From the upper limiting electron velocity used, $7\sqrt{\text{volts}}$, down to $3\sqrt{\text{volts}}$, the curve for acetylene rises continuously and regularly, with no maximum; between 3 and $2\sqrt{\text{volts}}$ it has a horizontal tendency, while between 2 and $1\sqrt{\text{volts}}$ it shows a very sharp maximum. The ethylene curve exhibits a distinct maximum at about $3\sqrt{\text{volts}}$, then a rapid fall to about two-thirds of the maximum value at about $2\sqrt{\text{volts}}$, and subsequently a rise to a sharp maximum, of approximately the same value as the first, between 2 and $1\sqrt{\text{volts}}$.

Comparison of the curves for nitrogen and acetylene shows well-marked and high initial maxima at the same velocity, and the one curve may be easily conceived as having arisen from the other. With the exception of the similarly constructed carbon monoxide, none of the other fifteen gas examined shows this characteristic maximum of nitrogen so distinctly. The maximum of the nitrous oxide curve is most like that of the new curves, but the similarity either at the maximum or elsewhere only approximates to that between nitrogen and acetylene. Similar relationships exist between the oxygen and ethylene curves.

Discussion of Grimm's hydride displacement law in relation to these cross-section curves leads to the conclusion that substantial agreement exists. T. H. P.

506. Exclusion Principle and Aperiodic Systems. N. F. Mott. *Roy. Soc., Proc*. 125. *pp*. 222–230, *Aug*. 1, 1929.

The collision between an electron and an atom is discussed. The wave-function must be antisymmetrical in the co-ordinates of all the electrons present. If the magnetic moments of the scattering atoms have been orientated by a Stern-Gerlach experiment, then the scattered beam of electrons will be polarised. It is shown how this polarisation could be detected. F. S.

507. Second Order Wave Equations of the Spinning Electron. G. Temple. *Roy. Soc., Proc*. 125. *pp*. 152–156, *Aug*. 1, 1929.

The author has previously attempted to transform Dirac's wave equations into a tensorial form [see Abstract 1457 (1929)], but it appears that no system of tensorial equations exists (for a 4-vector wave function) which is equivalent to Dirac's first-order equations. It is here shown that it is possible to construct a system of equations which is equivalent to Dirac's second-order equations, and the general theory of a system of second-order equations satisfied by a wave tensor of first rank is given. Vectorial notation is employed to facilitate comparison with the procedure of electrodynamic theory. The general features of Dirac's theory are reproduced by employing the non-commutative properties of the operations p and D to introduce the spin corrections into the Schrödinger-Gordon equation. H. N. A.

508. Quantum Theory of Vibrating Continua. F. Möglich. *Ann. d. Physik,* 2. 6. *pp.* 676–706, *Aug.* 26, 1929.

Canonical transformations for continua of co-ordinates analogous to those of classical point-mechanics are sought. With the aid of these transformations the existence of action- and angle-variations in a continuum of co-ordinates is ascertained. In place of the action-variables are set matrices, whose values are integral multiples of Planck's h. The total energy can then be expressed in terms of multiples of discrete energy-elements, $h\nu_k$, where the frequency ν_k has a certain range. In this there is no point of zero energy. An expression is also found for the energy-density, which works in harmony with the expression for the total energy, and passes over into the classical expression for the energy-density. From this is derived Einstein's radiation-variation formula. A. D.

509. Causality Law and Quantum Mechanics. L. Infeld. *Zeits. f. Physik,* 57. 5–6. *pp.* 411–415, 1929.

It is shown on the basis of an analysis of the imaginary experiments of Heisenberg and of Kellner [see Abstracts 38 (1928) and 2961 (1929)] that it is impossible to assign a physical meaning to the problem of distinguishing between causality and acausality in quantum mechanics. Using the concepts by means of which we build up the universe it is impossible to describe the instruments which would be required to carry out measurements on electrons and protons, and would correspond to the rigid measuring rods of macrophysics. Indirect measurements in the latter case are only justified by the fact that such measurements have been shown to give the same results as direct ones. H. N. A.

510. Relative Probabilities of the Ionisation of K and L Electrons of Equal Ionisation Energy. G. L. Pearson. *Nat. Acad. Sci., Proc.* 15. *pp.* 658–664, *Aug.*, 1929.

The probability of ionisation may be dependent on the quantum numbers of the electron. It has already been shown that since the values of V_0 the excitation voltage are practically identical for the three L sub-series of any element, and since in proceeding from L_{21} to L_{22} the azimuthal and radial quantum numbers remain fixed, while the inner quantum number changes from 1 to 2, it is possible to deduce the effect of change in the inner quantum number. A comparison of the K and L_{11} series involves a change in the radial number only, and between K and L_{21} only the azimuthal number changes; for a single element, however, there is considerable difference between the values of V_0 for the K and the L series. In the author's experiments the target contained two elements, chosen so that V_0 for the K series of one was nearly the same as V_0 for the L series of the other; pure lead selenide was chosen for this purpose. It has been shown that a difference in azimuthal quantum number has no appreciable effect; but a difference in radial quantum number has a great effect. H. N. A.

511. Noteworthy Discrete Eigen Values. J. v. Neumann and E. Wigner. *Phys. Zeits.* 30. *pp.* 465–467, *Aug.* 1, 1929.

The wave equation for an electron in a selected, spherically symmetric potential field V(r) is considered. According to prevailing views if the system has total energy E equal to 0, only a continuous spectrum is to be expected. It appears, however, that if $V(r) = (2r^{-2} - 9r^4)\frac{h^2}{8\pi^2 m}$, then $E = 0$ corresponds to a stationary motion. With this potential law, the classical motion would correspond to the electron swinging out to an infinite distance, which it would reach in a finite time after which classical mechanics makes no further pronouncement about the motion. The quantum mechanics appears to go further, and allows the electron to be reflected at the infinitely distant boundary, and so to set up a periodic motion. A further example is given of discrete eigen values where continuous spectrum would be expected, and in this case a semi-classical "explanation," as given above, does not apply. The results indicate that caution must be exercised in concluding that discrete eigen values do not occur in certain physical problems, such as the Stark effect. W. S. S.

512. Behaviour of Eigen Values in Adiabatic Processes. J. v. Neumann and E. Wigner. *Phys. Zeits.* 30. *pp.* 467–470, *Aug.* 1, 1929.

The problem discussed is the probability of two eigen values becoming equal to each other in the continuous variation of one or more parameters of the system (adiabatic variation). For an n-dimensional quantum mechanical system the question is: how many parameters must in general be varied for two eigen values to come into coincidence. It is shown that in general *three* real parameters must be suitably varied. The result obtained is applicable primarily to co-ordination questions, such as the co-ordination of eigen values, in weak and strong magnetic fields. Even with perpendicularly disposed magnetic and electric fields (two parameters) crossing of eigen values need not be feared, but if a third parameter, the angle between the fields, be varied, then a coincidence of eigen values can be forced. Another application is to London's theory of chemical reaction. W. S. S.

513. Material Waves and Material Rays. W. Alexandrow. *Ann. d. Physik*, 2–5. *pp.* 485–497, *Aug.* 15, 1929.

The author deals with the analogy between the Poynting vector in electromagnetic theory and the "probability current" introduced by Dirac in his wave mechanics theory of the electron. Just as Poynting's vector represents the ray in classical optics and its absolute magnitude divided by the energy density of the radiation equals the velocity of the light, so the field lines of the probability current represent the paths of the electrons (in the old sense, and only so far as the notion of path can be retained). The absolute magnitude of the probability current divided by the probability density gives the velocity of the particle, a result which follows from de Broglie's relation between the material wave-length and the momentum of the electron. The parallelism between Dirac's theory and the Weyl-Eddington field theory is also developed. In the latter the relation between light quant and wave is precisely the same as that between electron and wave in Dirac's theory. The cosmic length (radius of the world) plays the same rôle in Weyl's field theory as does the atomistic Compton wave-length $\left(\lambda_0 = \frac{h}{me}\right)$ in Dirac's theory. The dualisms, de Broglie wave-electron and (light wave)–(light quant) are discussed from several aspects. [See also next Abstract.] W. S. S.

514. Momentum of the Light Quant. W. Alexandrow. *Ann. d. Physik*, 2–6. *pp*. 646–648, *Aug*. 26, 1929.

In a previous paper [see preceding Abstract], the author has discussed the flow of energy in the radiation field compared with the probability flow of Dirac's quantum equations. In the present note the flow velocity of the wave momentum is considered from the same standpoint. [See also next Abstract.] W. S. S.

515. Hyperbolic Trajectories and α-Particles in Rutherford's Experiment According to the Extended Wave Mechanics. W. Alexandrow. *Zeits. f. Physik*, 56. 11–12. *pp*. 830–837, 1929.

The field lines of the "probability current" of wave mechanics are determined for the case of a plane material wave with positive charge, scattered by the central field of an atomic nucleus. The field lines are shown to be the hyperbolic trajectories of the α-particles as worked out classically. The wave mechanics notion of particle velocity (or flow velocity = ratio of the probability current to the probability density) is extended to include the concept of particle acceleration. It is then shown that the flow lines of the positive material wave, in the above example, give the correct acceleration for the Coulomb law of repulsion between α-particle and atom centre. [See also the two preceding Abstracts.] W. S. S.

516. Wave Velocity and Velocity of Flow (Corpuscular Velocity) of a Wave. W. Alexandrow. *Zeits. f. Physik*, 57. 5–6. *pp*. 380–386, 1929.

A suggested explanation of the contradiction between the ideas "wave" and "corpuscle" in the theories of matter and of light. Reviews the results of previous articles. In the case of a wave of the kind treated by Dirac, or by Weyl and Eddington, three velocities must be distinguished, the de Broglie phase velocity, which is greater than the velocity of light, and has no real physical meaning, the observable velocity of flow (corpuscular velocity), which is lower than that of light, and, finally, the wave velocity, which is identical with c the velocity of light. This is the upper limit, which is unattainable, of the velocity of flow. The velocity of flow of light quanta is very near to c. Deals with the mass of light quanta. In the case of waves of matter it is stated that the corpuscle can be observed because what is spoken of as corpuscular velocity is the velocity of flow of the wave. The flow of the wave is the only thing that can be observed; there is really nothing that can be localised. H. N. A.

517. Material Waves and Refraction of Light Quants. H. Bauer. *Phys. Zeits*. 30. *pp*. 597–603, *Sept*. 15, 1929.

In the author's previous analysis [see Abstract 2111 (1929)] the refraction of light quants was obtained by setting the rest mass equal to zero in a general expression applicable to all wave packets. The dispersion formula obtained was not in agreement with experimental optics. It is now assumed that in passing from a vacuum to a medium, every particle is subjected to the action of forces due to the atomic fields in the medium, these forces acting on the *mass* of the particle. If the particle possesses electric charge there is in addition the electrostatic force. For a light quant, however, only the first-mentioned forces are involved. Using this conception, a dispersion formula is derived which can, it is shown, be fitted on to optical dispersion data for actual substances, assuming a suitable potential for the "mass-proportional" forces, as a function of the frequency of the wave packet (or particle). When the wave packet is an electron or proton the " mass-proportional " forces are shown to be negligible compared with the electrostatic forces. W. S. S.

518. Propagation of Mechanical Processes in a Linear Lattice. F. Pollaczek. *Ann. d. Physik,* 2. 8. *pp.* 991–1011, *Sept.* 15, 1929.

Calls attention to Schrödinger's work on the behaviour of an infinite linear point lattice in connection with calculations on the specific heat of solid bodies, and shows that the alterations in *position* of the points of such a lattice will in general (neglecting the propagation of the wave fronts) only differ a little from the analogous processes in a continuum; the order of magnitude of the difference can be given exactly with relation to the number n of mass points per unit of length of the approximated continuum, if assumptions are made as to the " constancy " of the initial values of the positions of the mass points and their velocities. It appears that *these* processes will still take place in the lattice as they do in the continuum if the initial values only alter to a marked degree along lengths which are large compared with $n^{\frac{1}{3}}$ times the molecular distance. On the other hand, leaving out of consideration reflexions at the lattice ends, there is no similarity between the *velocities* of the lattice points and the velocities at the corresponding positions in the related linear continuum. An analogy is found with the processes to be observed in artificial cables in which Pupin coils are distributed along the cable. The fronts of the current waves may be represented by a curve similar to that calculated for mechanical waves by the author. H. N. A.

519. Calculation of Matrices for the Hydrogen Atom. W. Gordon. *Ann. d. Physik,* 2. 8. *pp.* 1031–1056, *Sept.* 15, 1929.

A detailed mathematical derivation is given of the matrix components for the coordinates x, y, z, for the hydrogen atom, when separation into polar and parabolic coordinates (Zeeman and Stark effects) has been effected. The continuous spectrum is included. W. S. S.

520. Effect of Retardation on the Interaction of Two Electrons. G. Breit. *Phys. Rev.* 34. *pp.* 553–573, *Aug.* 15, 1929.

Dirac's equation for a single electron makes it possible to derive the electronic spin, and assign values to its angular momentum and magnetic moment. Darwin has shown how the equation can be used in spectroscopic problems, giving an approximation to within terms in $(v/c)^2$. The author has obtained a similar equation for two electrons, with similar approximation for the energy; it is reduced to a form which can be interpreted in terms of electronic spins. It is shown that the result is different when the effect of retardation of the two electrons is considered, and when this effect is neglected; and that the difference is such as to affect the fine structure of orthohelium. The modification is appreciable only for spectra of elements with low atomic numbers. It is premature to claim experimental agreement with the helium fine structure before the proper functions of the 2^3P state are worked out, and the perturbation calculation is made with them in such a way as to be sure about the accuracy of the result. H. N. A.

521. Derivation of the Dirac-Whittaker Wave Equations from the Equations of Einstein's Unified Field Theory. R. Zaycoff. *Zeits. f. Physik,* 56. 11–12. *pp.* 862–864, 1929.

The author shows that the Dirac–Whittaker form of quantum theory conforms with the requirements of Einstein's unified field theory. [See Abstract 3257 (1929).] J. S. G. T.

522. Derivation of the Dispersion on Dirac's Theory of the Electron. K. Nikolsky. *Zeits. f. Physik*, 56. 9–10. *pp.* 709–712, 1929.

The perturbation method used by Schrödinger is applied to the case of an electron moving in accordance with Dirac's quantum mechanics equations, when a plane polarised light-wave is incident on the system. The dispersion formula deduced in this way has the same form as Schrödinger's, a modified meaning being attached to the matrix elements. The latter coincide with Schrödinger's, however, if the wave-length of the incident light is large compared with the atom size, or if for the unperturbed system the Schrödinger wave equation gives an adequate approximation.

W. S. S.

523. Geometrical Form of Dirac's Theory of the Electron. V. Fock. *Zeits. f. Physik*, 57. 3–4. *pp.* 261–277, 1929.

Using the notion of parallel displacement of demi-vectors [see Abstract 3492 (1929)], Dirac's equations are transposed into a generally invariant form. The energy tensor is derived, and the macroscopic as well as the quantum mechanical equations of motion are developed. A geometrical explanation is found for the occurrence in the wave equation of the expressions $\left(p_i - \frac{e}{c}\phi_i\right)$. It is also shown that the electromagnetic potentials ϕ have an independent place in the geometrical scheme of the universe, and are not functions of the Ricci coefficients as in the new theory of Einstein. In an Addendum the relation of the present viewpoint to that of Weyl [see Abstract 2689 (1929)] is discussed. W. S. S.

524. Relations of Dirac Equation in Tensor Analysis. C. Lanczos. *Zeits. f. Physik*, 57. 7–8. *pp.* 447–473, 1929.

Deals with Dirac's equation for the electron by means of quaternions, making use of a new formalism which seems to be suitable in some considerable degree for this problem. A definite path opens to a covariant formulation of the equations, by means of ordinary tensor calculations, by assuming a " doubling " of the Dirac equation. The resulting system can be resolved into two parts: the first corresponds to the coupling of an antisymmetrical tensor with a vector of the same structure, such as exists in the Maxwell equations as the relation between electromagnetic field intensity and current vector; the second part gives a " back coupling " in the form of a reaction of the current vector on the field intensity of the same structure, such as is known in the electromagnetic field as the connection between vector potential and field intensity. [See also next Abstract.]

H. N. A.

525. Covariant Formulation of Dirac's Equation. C. Lanczos. *Zeits. f. Physik*, 57. 7–8. *pp.* 474–483, 1929.

Continuing the author's previous paper [see preceding Abstract] the method there used is extended to the case where there is an external electrical field, and the covariant formulation is again applied. The system of equations obtained is unsatisfactory in several points, which are discussed, and contains elements which cannot be explained. Still it seems possible that the method employed is not altogether a wrong one, and it may lead to a development of Dirac's theory which, when developed by tensor analysis, will give a system of equations showing more inner probability than those now developed. H. N. A.

526. Conservation Law in Representation of Dirac's Equation in Terms of the Field. C. Lanczos. *Zeits. f. Physik*, 57. 7–8. *pp.* 484–493, 1929.

Refers to two previous papers [see the two preceding Abstracts], and shows that in the new theory no vector corresponds to Dirac's current vector, but that a tensor corresponds to it, the tensional energy tensor. To Dirac's conservation law corresponds the law of conservation of impulse and energy. The tensional energy tensor can be resolved into two parts: one electromagnetic, which has the same structure as the tensional energy tensor of Maxwell's theory; and the other mechanical, which follows the laws of hydrodynamics. The organic connection existing here between these two tensors removes the known contradictions which have attached to the dynamics of the electron theory. H. N. A.

527. Lorentz Invariance of Dirac's Electron Theory in Vector Form. E. Madelung. *Zeits. f. Physik*, 57. 9–10. *pp.* 573–574, 1929.

It is shown by direct substitution that the equations laid down by the author [see Abstract 2544 (1929)], giving Dirac's theory of the electron in vector form, are invariant under a Lorentz transformation of space and time. W. S. S.

528. Most Recent Formulation of Einstein's Unified Field Theory. R. Zaycoff. *Zeits. f. Physik*, 56. 9–10. *pp.* 717–726, 1929.

In continuation of previous work [see Abstracts 2118 and 2969 (1929)] the author extends and completes the derivation of the equations of the unified field theory on the basis of the Hamiltonian principle. Objections to the geometric principles of Einstein's theory are briefly answered. J. S. G. T.

529. Properties of a Unitary Physical Theory. Part I. L. L. Whyte. *Zeits. f. Physik*, 56. 11–12. *pp.* 809–817, 1929.

The author is concerned with those general properties which a unitary physical theory, *i.e.*, one representing gravitation, electromagnetism and quantum effects as aspects of a universal structure type, must possess whatever form the theory may take. In the present Part I the occurrence of a universal constant of the dimensions of a length is dealt with. Newton's and Maxwell's theories involve no such constant. It is shown that a unitary theory must contain a universal constant of dimensions L^1. The six universal constants, c, g, M, m, e, h, yield four independent lengths, between which in a unitary theory three relations must subsist. One of the latter is $\frac{hc}{2\pi e^2}$ = a non-dimensional constant = α. Eddington's theory [see Abstract 1613 (1929)] leads to $\alpha = 136$, the number of terms in an array of sixteen rows and columns. W. S. S.

530. Riemannian Spaces with Constant Coefficients of Rotation. G. Vranceanu. *Comptes Rendus*, 189. *pp.* 386–389, *Sept.* 2, 1929.

It is shown that the necessary and sufficient condition that in a Riemanniam space, V_n, it may be possible to select a system of n orthogonal congruences having constant Ricci coefficients of rotation is that the space is characterised by a continuous (real) singly transitive group of isometric transformations. J. S. G. T.

METEOROLOGY, GEOPHYSICS AND ASTROPHYSICS.

531. Weather and Wireless. R. A. W. Watt. *Roy. Meteorolog. Soc., J.* 55. *pp.* 273–302, *July*, 1929.

This paper is an account of the Symons Memorial Lecture of the Royal Meteorological Society and is a useful summary of the present state of knowledge as to the origin, range and form of atmospherics and their relation to meteorological phenomena. Reference is also made to the relation between meteorological phenomena and the various phenomena of the propagation of wireless waves. The possible use of facsimile radio transmission for sending weather charts to airships and other aircraft is mentioned, and actual demonstrations were given at the lecture. F. S. B.

532. Cloud Height according to Direction of Motion. A. F. Piippo. *Monthly Weather Rev.* 57. *pp.* 154–155, *April*, 1929.

The average altitude of the cloud base above the surface is set out for summer and winter at Madison, Washington and Blue Hill for stratus, strato-cumulus, cumulus, alto-stratus and alto-cumulus, according to their direction of motion, N, E, S or W. Convective Cu and A. Cu occur at a fairly common height for all three places, but stratiform clouds are found to occur at different elevations for the three stations. R. S. R.

533. Structure of Wind. W. Schmidt. *Akad. Wiss. Wien, Ber.* 138. 2*a*. 3–4. *pp.* 85–116, 1929.

A new apparatus for measuring wind velocity is described. By its means simultaneous observations on a series of closely adjacent points can be taken, and by employing kinemaphotography these can be repeated at determined intervals. In this way the fine structure of the wind stream can be determined. Observations at a number of differing localities are recorded, showing the effects of the ground relief, sea surface, open grass land, etc. The law of velocity-changes, according to the experiments, has a much larger exponent than that usually given in the accepted theory. W. A. R.

534. Barometric Scale of Height. H. Ebert. *Zeits. f. Instrumentenk.* 49. *pp.* 407–414, *Aug.*, 1929. *From the Reichsanstalt.*

The relationship between the air pressure and the height of the station at which the observation is made depends upon various physical and meteorological factors. Humidity of the atmosphere, temperature of the earth at sea-level and diminution of temperature with height all play prominent parts. Since these influences can be directly assessed a great number of numerical relationships can be found between the pressure measured in mm. of Hg and the height above sea-level (measured in metres), thus giving rise to the barometric height formula or height scale. The accuracy of such measurement, and the units of expression of height and the theory of the scheme of measurement are discussed. The paper also records the regulations arising therefrom issued by the Reichanstalt with all calibrated aneroid barometers. Full theoretical and practical details are given. S. G. B.

535. Nocturnal Illumination of the Upper Atmosphere over Göttingen. L. A. Sommer. *Zeits. f. Physik*, 57. 9–10. *pp.* 582–600, 1929.

Employing a spectrograph constructed specially for observations of the night sky illumination of extreme intensities in the upper atmospheric levels above Göttingen, hitherto unknown bands were photographed and measured, in addition to the known auroral line (λ5577·350) and the two lines discovered by Lord Rayleigh and Slipher. These lines are of extremely feeble intensity compared with the auroral line, but are still recognisable, and have spectral structure showing good agreement. Most of the new wave-lengths are determined. Besides the well-known bands found in the laboratory and by auroral observations, the second positive and first negative groups of the nitrogen molecule occur. Further bands and lines occur, as in the aurora, which cannot, at present, be classified. By these observations, Lord Rayleigh's assumptions that the auroral and night sky illuminations are two distinctly different physical phenomena lose an important support. [See Abstract 483 (1929).] R. S. R.

536. Height of Ozone in the Upper Atmosphere. F. W. P. Götz and G. M. B. Dobson. *Roy. Soc., Proc.* 125. *pp.* 292–294, *Sept.* 2, 1929.

A more recent determination of the constant of the spectrograph shows that previous results [see Abstract 73 (1929)] gave heights about 18 km. too low, and that the average height should be about 50 km. Observations for a further period of six months, coupled with those previously made, give some indications that the height is greatest in spring, and is not on the average lower when there is much ozone present than when there is little, but if there is any difference, rather the reverse. C. A. S.

537. Investigations on Heavy Ions in the Atmosphere. H. Israël. *Gerlands Beitr. z. Geophys.* 23. 2. *pp.* 144–166, 1929.

The paper forms a preliminary statement. Two methods of measurement are described to obtain the number and mobility of the heavy Langevin ions in the atmosphere. In both methods the air is drawn perpendicularly through an electric field and there discharged. The results of a four months' test in a large town are investigated statistically and the dependence of these figures on various meteorological factors obtained. The number of ions found agrees well with former results. The ratio N/n of large to small ions is 15 and the ratio N_0/N of Aitken nuclei to heavy ions is 6–7, thus about 15 % of the condensation nuclei are charged. An inverse relation exists between small and large ions in that an increase of one involves a decrease of the other. An important decrease in the number of heavy ions is established from February to May, showing an annual change similar to that for potential gradient. The number of heavy ions decreases with improved visibility and decreased relative humidity, and a parallelism exists with potential gradient changes. Relations are also established between ionic content and (1) the wind direction, (2) the origin of the air according to Bjerknes phraseology. R. S. R.

538. Relation between Temperature and Pressure Anomalies and the Changes of Axis of the Earth. R. Spitaler. *Gerlands Beitr. z. Geophys.* 23. 3. *pp.* 269–291, 1929.

After some preliminary remarks on the movement of the pole it is shown in some examples that there is a close connection between the anomalies of temperature and of atmospheric pressure of mean values in winter and summer months of many years, and the respective positions of the momentary pole. By this is verified the shifting of air-masses in consequence of a change in the rotation-axis of the earth, as was shown in a previous paper [see Abstract 3281 (1929)]. A. D.

539. Atmospheric Gravitation Waves. F. M. Exner. *Akad. Wiss. Wien, Ber.* 138. 2*a*. 3–4. *pp.* 223–244, 1929.

Atmospheric pressure changes have hitherto been mainly considered from the standpoint of temperature variation. Changes in the height of the atmosphere as the effects of gravitation waves must theoretically have their place. Equations are worked out giving the effects of atmospheric waves of this type using various assumptions. It is shown that the theory explains well the W–E drift of alternating areas of high and low pressure in mid-Europe. Formulæ for the velocities of these waves are derived. Waves are considered in two dimensions. The effect of a third dimension, and that due to earth rotation, are problems left over for further consideration. W. A. R.

540. Orientation of the Earth's Equatorial Ellipse. C. Mineo. *Comptes Rendus*, 189. *pp.* 481–482, *Sept.* 30, 1929.

By using exact formulæ for the potential due to an ellipsoid, it is shown that Bossolasco's thesis is invalid. [See Abstract 2123 (1929).]
W. G. B.

541. Torsion Balance in the Determination of the Figure of the Earth. D. C. Barton. *Am. J. Sci.* 18. *pp.* 149–154, *Aug.*, 1929.

A non-mathematical account of the observations obtainable directly from the Eötvös balance, and of the information deducible therefrom regarding gravity variations and, hence, of unsymmetrical distribution of mass. The special value of the torsion balance is as a supplement to pendulum observations, which in general are carried out at stations rather far apart. Torsion-balance observations are readily carried out at short intervals between such stations, and are of at least equal accuracy with pendulum observations. Such have already disclosed numerous gravity anomalies (examples given) of considerable magnitude in the south-west United States, where the balance has been much used in oil prospecting. The more extensive use of the balance in this way is urged.
C. A. S.

542. Astronomical Methods of Determining the Figure of the Earth. W. D. Lambert. *Am. J. Sci.* 18. *pp.* 155–163, *Aug.*, 1929.

These methods are fundamentally mechanical rather than geometrical, and determine the mean flattening of the earth alone, giving no clue to its linear dimensions nor to its local irregularities. Probably the most accurate is that based on the precession of the equinoxes, for the results are in excellent agreement with the best results from triangulation and from gravity determinations. Studies of lunar parallax and of variation of latitude can be made to give us more than the mean flattening, and because the method is so different from that of more direct methods, these deserve further trial, both from the geodetic point of view, and also because of the incidental advantages to astronomy. M. A. E.

543. The Alps and Isostasy. R. Schwinner. *Gerlands Beitr. z. Geophys.* 23. 1. *pp.* 35–92, 1929.

An old mountain system, trending north-south, is inferred, on geological grounds, to lie beneath the Calcareous Alps, and to form a hidden connection between the Bohemian mass and the Central Alps. Gravity determinations are strikingly anomalous and require considerable modification of the accepted theory of isostasy if they are to be explained. It would appear on all grounds as if the disturbances are caused by inflow of heavy material upwards into fissures disposed according to the structure of the old range. Earthquakes in this region are paradoxical in their extent, and these fissures of heavy material may act as "conducting leads" for seismic energy between the Central Alps and the Bohemian Mass. W. A. R.

544. Elastic Properties of Certain Basic Rocks and Their Constituent Minerals. L. H. Adams and R. E. Gibson. *Nat. Acad. Sci., Proc.* 15. *pp.* 713–724, *Sept.*, 1929.

By the method of total immersion (in *n*-butyl ether) the compressibility at pressures from 2000 to 12,000 megabaryes (approximately atmospheres) has been determined for labradorite (1·44, 0·1), jadeite (0·75, 0), grossularite (0·6, 0) and almandite (0·57, 0). [The figures in brackets are the values of $b \times 10^6$ and $c \times 10^{10}$ in the equation $-\Delta V/V = a + b(P - 2000) - c(P - 2000)^2$.] The compressibility, $\beta = -dV/V_0dP$ ($\times 10^6$) of four varieties of diabase (*anglicè* dolerite) similarly determined, varies from 1·23 to 1·7 at 2000 mb., and from 1·07 to 1·3 at 10,000 mb., approximating more and more closely to the figure calculated from their constituents as pressure increases. These results give a maximum velocity for longitudinal elastic waves at a depth of 50 km. in average basalt of 7·3 km./sec. compared with 7·9 observed, and indicate the probability of eclogites (for which $\beta \times 10^6$ is calculated to be 0·73 — 0·83) or peridotites predominating at such depths. C. A. S.

545. Use of Electricity for Investigating the Sub-Soil. H. Haalck. *Gerlands Beitr. z. Geophys.* 23. 2. *pp.* 99–143, 1929.

The paper contains a general review of the various electrical methods employed in the investigation of the soil. The methods described include those in which (1) d.c. and (2) a.c. are used. In the former the methods employing natural earth currents and those artificially introduced are included and also resistance methods. For the latter equipotential lines, electromagnetic, phase-displacement and electrodynamic methods are considered. Lastly, general conclusions are drawn regarding the geological point of view and the difficulties in the general application of the methods. R. S. R.

546. High-Frequency Method for Registration of Ground Vibrations. P. Liechti. *Gerlands Beitr. z. Geophys.* 23. 2. *pp.* 213–228, 1929.

The essential part of the apparatus consists of a condenser in which the capacity is varied by earth vibrations, which set up oscillations on a mercury surface supported beneath a metal plate. The condenser circuit is coupled inductively to a high-frequency tube transmitter. By working on the straight-line part of the resonance curve, the capacity changes are practically proportional to those of the anode current. These are registered photographically by an aperiodic, damped, short-period mirror galvanometer. Diagrams show the superposition of the ground vibrations on those of the Hg surface acting as a free membrane. The apparatus is simple in construction and use, may be easily transported, and its high sensitivity can be increased further by stages of low-frequency amplification. R. S. R.

547. Electrodynamic Measurement of Glacier-Ice. W. Stern. *Gerlands Beitr. z. Geophys.* **23. 3.** *pp.* **293–333, 1929.**

The relations are developed between the capacity of a conductor of electricity and the depth of a stratum sufficiently differing from its surroundings in its conductivity or its dielectric constant. A method is described by which the thickness of the stratum can be determined. The ice and the glacier-bottom meet the requisite conditions for the measurement of the thickness of the ice. Methods and results of practical work in the Alps are given. It appears probable that the same method can be applied with modifications to the measurement of the thickness of Continental ice. A. D.

548. Theory of Wind-Driven Ocean Currents. J. E. Fjeldstad. *Gerlands Beitr. z. Geophys.* **23. 3.** *pp.* **237–247, 1929.**

The case of a stationary wind-driven ocean current is considered. The coefficient of eddy viscosity is calculated by means of the formula $\nu = 2\omega \sin \phi \int_0^z V^2 dz / V^2 \frac{d\psi}{dz}$, where ω is the angular velocity of the earth, ϕ the latitude, V the velocity, and ψ the direction of the current, z denotes the distance from the bottom. The computed values of ν may approximately be represented by the formula $\nu = 385\left(\frac{z + \epsilon}{h + \epsilon}\right)^{3/4}$. With this value of ν the equations of motion are integrated and the computed current is found to correspond closely to the observed. AUTHOR.

549. Vibration of Earth's Axis as Result of Sun's Rotation. R. Kolisko. *Ann. d. Physik,* **2. 4.** *pp.* **427–428,** *July* **26, 1929.**

The author established the equation $y\,(1/a - 1/A) = x - c$, where y is the number of days for a solar sunspot semi-period, a the period of rotation of the sun around its axis, A the sidereal year in days, x the number of whole solar rotations around its own axis and c five sidereal years. This leads to a mean horizontal intensity of the earth of 0·25108 c.g.s. units. R. S. R.

550. New Method of Representing Details of the Sun's Surface. da C. Lobo. *Comptes Rendus,* **189.** *pp.* **277–278,** *Aug.* **5, 1929.**

At the University Observatory of Coimbra, the solar spots, faculæ, and absorption markings are shown in one general view of the sun's disc, which will be prepared and published for every day on which spectroheliograms are available at Coimbra, Meudon or elsewhere. The visible hemisphere of the sun is represented as a plane by a new method of projection, by means of which all these phenomena can be drawn from the photographs in their correct relative positions and sizes. As an illustration of the method, a drawing of January 17, 1929 (on which the prominences at the limb are also inserted) is reproduced. It is hoped that these composite drawings, with their accompanying tables, will be useful to all who are engaged in solar research. M. A. E.

551. Comparison of the Spectrum of Sunlight Aurora Rays with the Spectrum of Lower Aurora in the Earth's Shadow. C. Störmer. *Nature,* **124.** *pp.* **263–264,** *Aug.* **17, 1929.**

Briefly describes experimental results which agree with the author's previous observations that the green auroral line 5777, which is very strong for the aurora in the earth's shadow, is very much fainter for the high sunlit aurora rays as compared with the ionised nitrogen lines 4728 and 3914. These high sunlit aurora rays are blue and violet in colour, and consequently this observation is in accordance with this coloration. Helium and hydrogen lines do not appear, as far as could be ascertained with the apparatus available, in the spectrum of these high rays. R. C. F.

552. Possibility of Observing an Emission Spectrum of the Calcium Substratum in the Galaxy. Y. Öhman. *Nature*, 124. *pp*. 179–180, *Aug*. 3, 1929.

By an approximate calculation it is shown that there is no possibility of detecting the *k* and H emission lines of calcium in the light of the night sky. It is, however, a possibility that the forbidden doublet $1\sigma - 1\delta\{\lambda 7293\cdot 43, \lambda 7325\cdot 91\}$ may be detectable, although, as it occurs in the red, its photographing might prove difficult. W. S. S.

553. Washington Moon Observations, 1894–1922. H. R. Morgan. *Astron. J.* 39. *No.* 926. *pp.* 135–138, *Aug.* 3, 1929.

The 2000 lunar observations have been reduced on a uniform basis; are compared with tabular places approximating those given by E. W. Brown's new tables; and the residuals in longitude and latitude (still in manuscript) are analysed. The author gives the particulars of the instrument used and the methods of observing. All observations have been referred to Newcomb's system for equator and equinox; he gives the observed corrections to the tabular semi-diameter for the periods, 1894–1903, 1903–1913, 1913–1922, and the corrections to the Newcomb-Hansen tabular places in the *American Ephemeris* as to (*a*) mean longitude, (*b*) true longitude, (*c*) latitude, (*d*) elements, and (*e*) nomenclature. The results for each year are summarised in a table, in whose last two columns are given comparisons with Brown's new tables which have been used in the *Ephemeris* since 1923. The longitude residuals have been tabulated by months and examined for terms of 7, 12, 13 and 14 lunations. The variations in 7 and 14 are less than $0''\cdot 2$, and those of 12 and 13 still smaller. A. S. D. M.

554. Polarisation of Light from Planet Mercury. B. Lyot. *Comptes Rendus*, 189. *pp*. 425–426, *Sept*. 16, 1929.

The author has shown previously [see Abstract 2220 (1924)] that the proportion of polarised light of Mercury measured at night when near his greatest elongation passes through a series of values very close to those found for the moon at similar phases, but these values were then limited to the angle of vision (angular distance of the earth and moon as seen from Mercury) between 60° and 130°; angles less than 60° were unsatisfactory, as of necessity made in daylight. Observations made on Mercury on the Pic du Midi with the aperture of 25 cm. stopped down to 18 cm. have permitted the planet to be seen in a very dark field, and some were obtained on August 3, 6 and 7, 1929, which gave planes of polarisation perpendicular to that passing through the sun, with proportions of light polarised; on 3rd with angle 12° 15′ of N.S. thousandth; on 6th, with 20° 5′ of 5·9; and on 7th with 22° 25′ of 1·7. The measures of the moon at the same angles with the polarisation perpendicular to the sun's plane gave proportions of polarised light as 11·9, 5·2 and 1·6 thousandths, the difference between the values for the two bodies being less than the errors of observation. A. S. D. M.

555. General Absorption of Light in Space. P. ten Bruggencate. *Zeits. f. Physik*, 57. 9–10. *pp*. 631–637, 1929.

It is shown that in the observation of distant stars there is a general absorption of light in space, dependent solely upon the distance from the earth. This consequently must be taken into account when the brightness of distant stars is being measured. A. C. M.

556. Coma-Virgo Galaxies. Part IV. Second Note on Form and Concentration. H. Shapley and Adelaide Ames. *Harvard Coll. Obs., Bull. No.* 868. *pp*. 3–9, *June* 1, 1929.

[See Abstracts 2426 and 2427 (1929).]

557. Study of Group of Eight Cepheids. G. Tiercy. *Arch. des Sciences*, 11. *pp*. 197–211, *July–Aug*., 1929.

The eight Cepheids are SU Cassiopeiae, T Vulpeculae, W Sagittarii, X Sagittarii, S Sagittae, Y Ophiuchi, X Cygni and η Aquilae. The author had found [see Abstract 1475 (1929)] that in the case of giant stars (Cepheids) the expressions hold good: $0{\cdot}8191 = \log R + 0{\cdot}2M_v + 0{\cdot}819\alpha - 0{\cdot}2\beta$; $T = 7200(1 - \alpha)^{-1}$ where the parameters α and β have values dependent on spectral type. For the eight stars numerical data are given of mass (μ), period, M*v*, mean M*v*, R, mean R, and mean I; also the mean spectral type and the range of spectral types. Ten diagrams are given, of which the most important are: mean curves which give (*d*), R_m if I_m is known; (δ), $(M_v)_m$ if I_m is known; (*c*) I_m as a function of the period; and curves of type F_5 which give (f_5), $I(F_5)$ if I_m is known; (ϕ or ϕ'_5), $R(F_5)$ as a function of I_m. A. S. D. M.

558. Empirical Formula Giving Distances of Formation of Successive Rings in Nebular Hypothesis. A. Auric. *Comptes Rendus*, 189. *pp*. 455–456, *Sept*. 23, 1929.

The author suggests $d = r(1{\cdot}764)^n$ as a simple formula for a geometrical progression in space, giving the distances *d* for formation of rings and framing suitably the eight known planets and the asteroidal zone, where *r* is the sun's radius, 0·00465 U.A. and *n* is the order of the ring. He tabulates these and finds that they give seven rings interior to Mercury. This formula is very similar to Gaussin's, $d = r(1{\cdot}722)^n$, published in 1880, and is indeed a readjustment of it. A. S. D. M.

559. Multiplet Intensities in the Flash Spectrum. W. H. McCrea. *Observatory*, 52. *pp*. 267–274, *Sept*., 1929.

The recent work of Unsöld on the forms of solar spectral lines [see Abstracts 1200 (1928) and 2696 (1929)] has thrown much new light on the way in which the reversing layer and the chromosphere combine in the building up of these lines. It is here shown that this leads to an understanding of some observational results on the intensities of lines in multiplets in the flash spectrum. The relative intensities in doublets in emission at sufficient heights in the chromosphere, and in prominences, should theoretically obey the simpler multiplet rules; and it is found by observation that, considering all the circumstances involved, the rules are surprisingly closely obeyed. It is also found that it is possible to predict the relative intensities in emission of the H-K doublet and the X triplet of Ca^+. The satisfactory agreement with observation appears to be very instructive. M. A. E.

LIGHT.

560. Transmission of Radiation Filters. W. Kaempfert. *Gerlands Beitr. z. Geophys.* 23. 2. *pp.* 167–212, 1929.

The author first defines radiation filters, and then gives a classification of those filters at present in use, considering their method of manufacture and mode of use. Filters for meteorological use have certain conditions to fulfil, and the requirements of such a filter are enumerated. Definitions of the terms reflection, absorption and transmission power, and absorption and transmission coefficients are then given, whilst an experimental method is developed, using the Bouguer–Lambert formula, whereby it is possible to ascertain the transmission, reflection power and transmission coefficient of a filter. The apparatus necessary is fully described, whilst the method of obtaining measurements and the evaluation of results are also considered in detail. Finally, the results of an examination of a number of filters are given, and the possibility of using these filters for meteorological measurements is discussed. It is found that Schott's red filter F4512 shows only a small increase of the percentage transmission with the breadth of the atmosphere passed through by the sun's rays, whilst for the other filters examined the transmission varies considerably with the altitude of the sun. R. C. F.

561. Relation between Density and Refractive Index of Silicate Glasses, with Application to Determination of Imitation Gem Stones. F. A. Bannister. *Min. Mag.* 22. *pp.* 136–154, *Sept.*, 1929.

The relation between refractive index and specific volume for glasses being approximately additive, that between the former (n) and density (d) is approximately linear for a series of glasses of the same family. But the lines for the various families of glasses in many cases converge at too small an angle to allow of certain identification by means of a simple refractive index-density diagram. When, however, the value of $(n - \mathrm{N})/(d - \mathrm{D})$, where N and D are the refractive index and density of the "parent substance," is plotted against n, the various families of glasses are found to separate out satisfactorily. For artificial gem glasses silica glass ($\mathrm{N} = 1{\cdot}46$, $\mathrm{D} = 2{\cdot}21$) is most suitable as "parent substance," and a $(n - 1{\cdot}46)/(d - 2{\cdot}21) - n$ diagram is shown to render identification a comparatively simple matter. Constants for four new thallium-lead glasses are also given, and it is shown that though on the diagram such glasses fall very near to lead glasses, they are readily distinguished by determining the dispersion, a method generally advisable in border-line cases. C. A. S.

562. Refractive Indices of Hydrosols. A. Dumanski and B. S. Putschkowski. *Kolloid Zeits.* 48. *pp.* 338–342, *Aug.*, 1929.

The authors investigated the change with concentration of the refractive index of hydrosols (gelatin, starch, tannin, iron hydroxide, etc.) in 1915, and arrived at the formula: $n = c_1(n_2 - n_1)/d_2 + n_1$, where n_1 and n_2 are the refractive indices of the dispersion medium and the disperse phase, and d_2 is the density of the latter. This formula agrees with that of Wiegner of 1917, and is now confirmed by further experiments with silicic, stannic and molybdic acids, zinc hydroxide and dextrin. According to the formula the ratio $(n - n_1)/c_1$ should be constant. This is found to hold except when the state of the colloidal particles changes with dilution, as is the case, e.g., when the sol of molybdic acid passes into a true solution of this acid. H. B.

563. Use of Binocular Vision for Fixation of Direction. A. de Gramont. *Rev. d'Optique*, 8. *pp.* 308–310, *Aug.*, 1929.

The author considers two straight lines arranged in planes normal to the lines of sight, each of which is only seen by one eye of the observer. The two straight lines are placed in positions such that they can be united in a single line. An apparatus is described which has permitted the accurate determination of one of these directions relative to the other. Results by different observers are compared and discussed. H. H. Ho.

564. New Formula for the Representation of the Sensitivity of the Human Eye. H. Schober. *Zeits. f. Physik*, 56. 9–10. *pp.* 702–708, 1929.

The author developed the formula of Haschek-Lasareff on the photochemical theory of vision and added to it slight correction factors. The assumption of monomolecularity of the photochemical processes is obtained solely in the explanation of the additional processes for new light sensitive substances. This formula for sensitivity is compared over a wide region with the experimental values and complete agreement is established.

R. S. R.

565. Light Excitations of Short Duration on the Eye in Obscurity. P. Lasareff. *Zeits. f. Physik*, 56. 11–12. *pp.* 845–850, 1929.

It was assumed that with the minimum sensitiveness the concentration of the exciting ions $C_1 = B_0 + B_1/t$, where B_0 and B_1 are constants and t is the time of the action of the light. On this assumption and the ionic theory of excitation a theoretical law was deduced for excitations of the retina of short duration in observations in the dark. This law has the form:

$$Jt = \frac{a + bt + \frac{c}{t}}{1 - \frac{d}{t}},$$

where J is the intensity of the exciting light, t the time of excitation, and a, b, c, d are constants. The results of investigation agree well with the formula given, yet it cannot be treated as a theoretical law since the conditions under which the formula is valid were not fulfilled experimentally. J. J. S.

566. Electrically-Conducting Antimony Mirrors on Glass. S. Miller. *J.O.S.A. and R.S.I.* 19. *pp.* 101–102, *Aug.*, 1929.

Satisfactory electrically-conducting mirrors of antimony on glass high vacuum apparatus have been prepared by the thermal decomposition of pure stibine. They do not sublime at 300° C. in a vacuum, but may be removed by sublimation at a temperature below the softening point of Pyrex. AUTHOR.

567. Transparency of Various Materials to Ultra-Violet Radiation. P. Wright. *Brit. J. Radiology*, 2. *pp.* 434–438, *Sept.*, 1929.

The results of experiments on the ultra-violet transmission limits of a number of glasses, crystals and other media. W. V. M.

568. Spectrophotometry in the Ultra-Violet. F. H. Gage. *Journ. Sci. Instruments,* 6. *pp.* 256–258, *Aug.*, 1929.

A simple apparatus is described for the determination of the absorption of ultra-violet light by solutions, providing for the rapid interchange of two cells containing respectively the solution and pure solvent. Spectrum photographs are taken alternately (*a*) through the solvent, with the intensity reduced to a known extent by a rotating sector, (*b*) through the solution at full intensity. AUTHOR.

569. Stereoscopic Estimates of Distance. M. Maurer. *Zeits. f. Instrumentenk.* 49. *pp.* 444–457, *Sept.*, 1929.

The author describes a series of experiments performed to find the factors determining the estimates of distance. He concludes, (1) that the form of the object has little effect on the accuracy of these estimates, some observers preferring one form and some another; (2) from different forms of lighting the magnitude of the contrast is the main factor and irradiation acts in a deleterious way; (3) intermittent illumination gives the same effect from whatever direction applied; (4) measurements of duration show fatigue phenomena. From all the tests he finds for normal experimental conditions a mean value of 11·8″ against 5″ for the coincidence method, this holding where stereoscopic measurement is expressed by pure parallactial view and not for the free eye or an apparatus where convergence and accommodation can act. Finally, the limits of depth are introduced and a definition and formula set up. He considers that measurements from persons flying ought to corroborate the formula. R. S. R.

570. Possible Connection between Planck's Constant *h* and the Ponderomotive Action of Circularly Polarised Light. S. Pokrowsky. *Zeits. f. Physik,* 57. 3–4. *pp.* 278–282, 1929.

All ponderomotive actions of elliptically polarised radiation can, it is shown, be derived by assuming circularly polarised light to consist of individual elementary "moments of momenta" equal to $\frac{h}{2\pi}$, whose axes lie parallel to the ray. W. S. S.

571. Interferometer Using Plane-Polarised Light. J. W. Beams, L. G. Hoxton and F. Allison. *J.O.S.A. and R.S.I.* 19. *pp.* 90–92, *Aug.*, 1929.

Whilst many instruments of this kind are already available, in every case where a high degree of precision is required, the operator must be highly skilled and the instrument of a very fine quality.

In the case of the instrument described, a reasonable degree of accuracy (about 1/100th of a wave-length) is obtainable without difficulty, the adjustments being simple and easily made. A monochromatic beam of light is first plane-polarised by a Nicol prism and then passed through a crystal of Iceland spar so oriented as to give two beams of equal intensity, polarised in perpendicular planes. Each of these two beams is reflected back by plane mirrors and recombined to form elliptically polarised light, which returns through the Nicol prism and is then reflected by a half-silvered mirror. At a particular position beyond this mirror a series of light and dark bands are formed, and if either of the two first-mentioned mirrors are moved, the position of the "fringes" or bands is changed. This change is recorded by the use of a mirror placed at the position where the "fringes" are formed which has portions of the silvering removed so as to leave slits. The reflected portions are directed upon one and the transmitted portions upon a second photoelectric cell, the two cells being in circuit with a galvanometer so arranged that changes in the position of the "fringes" result in deflections of the galvanometer. A method of calibrating the apparatus is briefly described. J. G. H. B.

572. Magnetic Birefringence in Solutions and its Relation to Crystal Structure and Properties. M. Ramanadham. *Indian Journ. Phys.* 4. *pp.* 109–129, *Aug.* 1, 1929.

Solutions of benzene, naphthalene, phenanthrene, azo-benzene and anthracene in carbon tetrachloride were examined. They showed positive magnetic double-refraction in the ascending order of magnitude. Nitro-aromatic compounds also in solution showed positive double-refraction, although less than they would show in proportion to the concentration. Aqueous solutions of maleic acid, nitrates and nitrites showed positive double-refraction, the last showing it pronouncedly more than the nitrates. Hexachloroethane in carbon tetrachloride and aqueous ammonium thiocyanate solution showed negative birefringence. An expression for the Cotton-Mouton constant of binary mixtures has been derived based on the premises of Langevin as modified by Raman and Krishnan. In order to connect the magnetic and optical properties of crystals with the magnetic birefringence exhibited by them in solution, the available data as regards magnetic and optical properties of the crystal were utilised to calculate the magnetic birefringence based on the assumption that the molecules inside the crystal are all parallel. The calculated values are found to be smaller than the observed ones. The difference may be due either to the orientation of the molecules in the crystal being different from that assumed, or to the magnetic anisotropy and susceptibility of the molecule not being the same in the solid as in the solution.

AUTHOR.

573. Magneto-Optical Dispersion of Some Organic Liquids in the Ultra-Violet. C. C. Evans and E. J. Evans. *Phil. Mag.* 8. *pp.* 137–158, *Aug.*, 1929.

Isopropyl alcohol, allyl alchohol and methyl acetate have been investigated in the violet and near ultra-violet regions of the spectrum; the refractive indices of the first and last two compounds have also been determined in the same part of the spectrum. Formulæ have been obtained for the magneto-rotary dispersions of all four compounds. For all four of them the results can be accounted for on the assumption in each case of one absorption band in the ultra-violet; the wave-lengths of these bands are 0·1137μ for isopropyl alcohol, 0·1372μ for allyl alcohol, 0·1117μ methyl acetate and 0·1140μ for ethyl acetate. H. N. A.

574. Simple Electro-Optical Experiment. A. Deubner and J. Malsch. *Phys. Zeits.* 30. *pp.* 506–508, *Aug.* 15, 1929.

The phenomena now described were observed during an investigation connected with the Kerr effect. When an unpolarised beam of light passes through a Kerr cell filled with nitrobenzene, which is subjected to voltages of different strengths both direct and alternating, the transmitted light is split up into lines which vary with the voltage. A theoretical explanation of the phenomena is attempted. H. H. Ho.

575. Magnetic Rotatory Power of Gases and Vapours. R. de Malleman and P. Gabiano. *Comptes Rendus*, **189.** *pp.* 281–282, *Aug.* 5, 1929.

The substances tested were CO_2, CS_2, SO_2, CH_2 and C_2H_5Cl. These were subjected to a magnetic field in a solenoid 1 metre long, and containing 21,276 turns of wire with a current capacity of 30 amperes. Double rotations were measured for three wave-lengths, and have a maximum of 3·24° for acetylene with λ436. At 0° and 760 mm., the rotatory powers × 10^6 are, for λ578, CO_2 9·4, SO_2 30·5, CS_2 84·5, C_2H_2 31·9, C_2H_5Cl 36·7. The values are compared with those found by other observers. G. E. A.

576. Natural and Magnetic Rotatory Dispersion of Crystals and Liquids. A. Ehringhaus. *Zeits. f. Krist.* **71.** 3. *pp.* 183–204, *Aug.*, 1929.

A study of rotatory dispersion based on readings for three wave-lengths only in the visible spectrum. T. M. L.

577. Photochemistry of Silver Iodide. Lüppo-Cramer. *Zeits. f. wiss. Phot.* **27.** *pp.* 1–8, *Aug.*, 1929.

A series of gelatin emulsions containing silver iodide and potassium bromide were prepared, and the effect of exposure to light of a known intensity was determined. The increase in sensitivity to light of silver iodide by the addition of silver bromide was shown by the exposure curves. The effects of the addition of potassium metabisulphite to different mixtures of silver iodide and bromide were also investigated, and the influence of grain size on the properties of the photographic plate was discussed. F. J. B.

578. Distribution of Silver Iodide in Silver Bromide. Lüppo-Cramer. *Zeits. f. wiss. Phot.* **27.** *pp.* 9–19, *Aug.*, 1929.

The influence of the addition of silver iodide to silver bromide emulsions was investigated. Standard emulsions were prepared and the silver bromide-iodide emulsions were compared with the standard by means of the darkening which took place when the plate was exposed to light. Photomicrographs were made of the emulsion with and without the addition of silver iodide, which clearly showed the influence of the addition of silver iodide upon the grain size. F. J. B.

579. Light Sensitivity of Solarised Silver Bromides. Lüppo-Cramer. *Phot. Indust.* **27.** *pp.* 853–854, *Aug.* 14, 1929.

Describes the results of further experiments on the Volmer reaction, which is the restored blackening, by illumination with red light, of a solarised illuminated plate. It is shown that not only is the wave-length of the light important, but also the intensity. It is possible to obtain the restored blackening by illuminating the plates by green or blue light, provided it is sufficiently intense. Considering the grey scale of the Eder–Hecht scale, the most intense light does not restore the blackening but enhances the bleaching, whilst blackening occurs from 20° onwards. The true Volmer reaction, using red light, is also greatly enhanced by impregnating the plates, after the pre-illumination, with nitrite, acetone-semicarbazone and very dilute developer solutions. This is probably due to the fact that, for weak intensities, the photographic reactions occur more on the grain surface. Desensitising dyes very greatly increase the sensitivity and density of the image on the solarised pre-illuminated plate, Sensitising dyes also possess this action, but not so pronouncedly.

R. C. F.

580. Halogen Silver Photochemistry. Part VI. Analytical and Photographic Examination of Halogen Silver. H. H. Schmidt and F. Pretschner. *Zeits. f. wiss. Phot.* 27. *pp.* 36–46, *Aug.*, 1929.

In this paper, which is a reply to the paper by Kieser on ripening nuclear silver [see Abstract 1525 (1929)], it is shown that there are definitely two silver values for silver chloride, for cold centrifuging gives 75 % of the silver of the silver value highly dispersed in the gelatin and 25 % absorbed in the grain. Further, for silver bromide emulsions the illuminated halogen exists in the atomic form, remains in the centrifuge and can be washed out from it. For silver chloride 95 % of the illuminated silver is dissolved in dichromate sulphuric acid and the sensitivity threshold value depends on the gradation of the quantity of illuminated silver. Thus, the objections of Kieser cannot be sustained, and further, although only 4 % of the silver value is not dissolved in dichromate sulphuric acid, the sensitivity can be ascertained with only this small percentage. As to the chemical nature of the surplus silver, it is not correct to say that 95 % of the quantity originally in the emulsion exists as sulphide. From a treatment of silver powder with dichromate sulphuric acid, the formation of silver chromate occurs as well as the dissolving of the silver. Publications by Lüppo-Cramer and Kieser as replies to the authors' third part of this examination [see Abstract 471 (1929)], in which an occlusion theory is developed to account for results obtained, are also discussed. It is shown that although there is one phenomenon which might support the theory, there are several which definitely oppose it. [See also Abstract 3315 (1929).]

R. C. F.

581. Colour Sensitivity Curves. J. M. Eder. *Phot. Indust.* 27. *pp.* 852–853, *Aug.* 14, 1929.

Discusses the applicability of the colour sensitivity curves for photographic plates, obtained experimentally by means of the sun's light, or calculated for equal spectral energy distribution, when used with various artificial light sources. It is shown that the new method, using equal spectral intensities, leads to some confusion. Thus, there is no need to depart from sunlight at midday on a summer's day or the recognised international equivalent of the light from burning magnesium [see Abstract 3029 (1929)], as the standard for photographic sensitometry. R. C. F.

582. Photochemical Reduction and Oxidation Processes. A. Steigmann. *Zeits. f. wiss. Phot.* 27. *pp.* 24–35, *Aug.*, 1929.

Discusses previously published results on the photochemical reduction and oxidation processes from electronic considerations, the addition of an electron representing a reduction process and the loss of an electron an oxidation process. It is shown that the photochemical reduction of the silver ions or a reducible group of atoms in a molecule can be accomplished by intermolecular photochemical oxidation and reduction, and by oxidation of the gelatin and reduction of the halogen silver ions or other reducible groups of atoms. Outside the limits of the silver bromide absorption region, the electron is given up by the gelatin or a reducing agent of illuminated dye, or else the electrons are provided by oxidisable atom groups. In the last case a desensitiser can act as a sensitiser. Reduction of silver halide does not occur when a body is present which takes up electrons more easily than does the silver halide. Considering a ternary photo-system, consisting of a reducing agent and two compounds which easily take up electrons for sensitising, it is found that that sensitised body is always the desensitiser for the sensitising agent used, and *vice versa* for desensitising. In no ternary system mentioned is it possible to obtain complete sensitisation or desensitisation, and where sensitisation is confirmed only the predominant sensitisation is meant. Different emulsions act differently with various desensitisers, and this is explained by means of the different activities of the ripening nuclei. R. C. F.

583. Theory of Hypersensitisation. K. Jacobsohn. *Zeits. f. wiss. Phot.* 27. *pp.* 19–23, *Aug.*, 1929.

Examines numerous commercial plates in order to ascertain the effect of trying to hypersensitise them. It is shown that only a few such emulsions are capable of being hypersensitised—in fact, the emulsions can be divided into three groups, those in which no action occurs, those whose colour sensitivity increases somewhat but whose normal sensitivity, as measured for blue-violet, does not change, and those in which there is an increase in both colour and normal sensitivity. In the latter group, two emulsions are particularly noteworthy, owing to the relatively large increases obtained. These large increases are apparently due to the ripening process used, and a comparison is, therefore, given for the action of pinachrome-pinachromeviolet sensitiser and also for hypersensitisation of a ripened emulsion and an ammoniacal emulsion. For pinachrome-pinachromeviolet sensitising, the total sensitivity is only slightly increased for both emulsions, whilst there is no change in the blue sensitivity. The green and red sensitivity show marked increases, and this is also true for the yellow or total sensitisation. When the emulsions are hypersensitised, however, only the ripened emulsion shows a large increase over the values for pinachrome-pinachromeviolet sensitisation, and the increase is observed for the separate colour sensitivities as well as for the total sensitivity. This phenomenon can be explained by the silver sulphide speck theory of Sheppard, and a brief discussion of the theoretical aspect is given.

R. C. F.

584. Inversion Appearances with Desensitisers. E. Mauz. *Zeits. f. wiss. Phot.* 27. *pp.* 45–59, *Sept.*, 1929.

The Herschel effect is only obtained with a pre-illuminated plate on exposing it to red or infra-red radiation [see Abstract 1521 (1929)]. A similar phenomenon can be obtained with radiations of shorter wavelengths, using plates dyed with desensitisers and then pre-illuminated. The author describes experimental results obtained in an attempt to answer the question as to whether there is any connection between the spectral region in which this inversion occurs, and the absorption spectrum of the desensitising dyes. Using fuchsin, phenosafranin, pinakryptolyellow and pinakryptolgreen desensitising dyes and working with plates immediately after treatment and also after ageing for four months, it is found that the absorption spectrum of the dye plays only a secondary part in the bleaching appearance; the position of the appearance of inversion is somewhat displaced. The inversion appearances are also only slightly dependent on the photographic film, the latter being strengthened or weakened by the dye treatment. The results obtained agree with Lüppo-Cramer's conclusion that the action of the dye on silver iodide can be considered to result in an adsorption saturation of the nucleus, the spectral absorption of the dye thereby only playing a subordinate part. R. C. F.

585. Relationship of Resolving Power of Photographic Material to Contrast in the Test Object. O. Sandvik. *Zeits. f. wiss. Phot.* 27. *pp.* 60–75, *Sept.*, 1929.

Obtains the relationship of the resolving power of five photographic emulsions to the test object contrast, from experimental results obtained by photographing a reduced image of the test object. The test object consists of a number of groups of five lines, three of the lines in each group being transparent and the other two opaque. All the lines in each group are identical in width, this width, however, being varied for different groups. By this means it is possible to obtain the minimum number of lines per mm. which can be resolved. Owing to the fact that the transparent lines have unity transmission and, therefore, zero density, the density of the opaque lines for each group is equal to the logarithm of the contrast. With low test object contrast values the resolving power is very low, but increases rapidly with increase of contrast. For unity contrast the resolving power is zero, whilst it reaches 76 % of its maximum value at a contrast value of 4·0 (density = 0·6), 83 % at a contrast of 7·1 (density = 0·85), and has its maximum values at contrasts between 100 and 300 (densities 2 to 2·5). The relationship between the resolving power and the test object density is given by the formula $R = C(1 - e^{-\alpha D})$, where R is the resolving power, D the density of the opaque portion of the test object and C and α are constants. Variations in the exposure greatly affect the resolving power, whilst, on the other hand, it is almost unconnected with gamma. [See also Abstract 1734 (1927).] R. C. F.

586. Crystal Structure Defects and Point Concentration. Theory of Photographic Light Sensitivity. A. Steigmann. *Zeits. f. wiss. Phot.* 27. *pp.* 76–79, *Sept.*, 1929.

Discusses the problems of photographic light sensitivity, considering published results dealing with crystal structure defects and also with the theory of point concentration. R. C. F.

587. Photographic Surface of Densities of Two Low Sensitivity Emulsions. H. Arens and J. Eggert. *Zeits. f. wiss. Phot.* 27. *pp.* 79–84, *Sept.*, 1929.

Obtains the tri-dimensional diagram of blackening of the two almost insensitive emulsions "Agfa-Diapositive" plates and "Agfa-Kinepositive" film. For normal illumination ratios these density surfaces are normal, *i.e.*, the Schwarzschild's exponent is almost equal to unity. With low intensities and long times of illumination, however, the surfaces bend, so that finally they are parallel to the time axis, and then $p = 0$. This peculiarity has already been observed for the blackening surfaces of desensitised emulsions which originally had high sensitivity values. [See also Abstracts 1248 (1928) and 472 (1929).] R. C. F.

588. Origin of the Latent Image. F. C. Toy. *Zeits. f. wiss. Phot.* 27. *pp.* 85–108, *Sept.*, 1929.

This paper includes the following matter: (1) A literature survey of the photo-conductivity effect in silver halides and similar substances. (2) A proof that this photo-conductivity in salts sensitive to light is due to the free motion of the electrons of the anion, *i.e.*, the anion is the ion sensitive to light. (3) The extent to which the photoconductivity and photographic effect run parallel, at one time as developer and then as a direct visible effect, is discussed from the spectral sensitivity basis, and it is shown that, apart from a very important apparent exception, this parallelism is very remarkable. (4) This exception, found by Coblentz for silver bromide, is proved to be a normal case. (5) The conclusion is drawn that the mechanism of the primary light process during the genesis of the latent image is probably the same as that of the photoconductivity effect. H. H. Ho.

589. Method of Calculating the Illumination Produced by Non-Point Sources Radiating According to the Lambert Law with Constant Brightness. J. Dourgnon and P. Waguet. *Comptes Rendus*, 189. *pp*. 361–363, *Aug*. 26, 1929.

Makes use of an imaginary sphere, tangent to the illuminated surface, and a conical surface the apex of which is at the contact point A, while the surface passes through the contour of the source; this cuts out a cap of area from the surface of the sphere, and if this has the same brightness as the source it will produce the same illumination as the source at A, and this can be calculated easily by means of the Sumpner-Ulbricht theory. H. N. A.

590. Parameters Characterising Partially Polarised Light in Fluorescence Phenomena. P. Soleillet. *Ann. de Physique*, 11. *pp*. 23–97, *July–Aug*., 1929.

From among the mean quantities used by Stokes to characterise elliptic polarisation of a luminous pencil, nine have been chosen which apply to fluorescent emission. In the first part of the paper the relations of these quantities are discussed, and it is shown that they are linear and homogeneous and that their 81 coefficients are characteristic of fluorescent media. In the second part the general case of depolarisation is considered in extension of previous work [see Abstract 1170 (1929)]. In the last part of the paper phenomena of anisotropic absorption are considered along the lines of the same theory. F. S.

591. Resonance-Fluorescence in Cyanogen Spectrum. H. T. Byck. *Phys. Rev*. 34. *pp*. 453–456, *Aug*. 1, 1929.

In a study of the spectra of organic compounds excited by streaming active nitrogen, the intensification of certain pairs of lines in the violet CN bands was observed. This phenomenon was reported recently by Herzberg, who likened this intensification to the resonance-fluorescence of iodine. The cause, according to Herzberg, is absorption of radiation of short wave-length from nitrogen bands in the far ultra-violet. Experiments were made to test this explanation. Radiation from the nitrogen discharge was found to have no effect on the appearance or non-appearance of these intensified doublets. Additional experiments were made to observe the effect of pressure on the appearance of the intensification, and it was found that such intensification depends upon the pressure under which the excitation of the CN spectrum occurs. It appears that the intensification results through collision with some higher-energy atomic or molecular species whose formation is suppressed at higher pressures. AUTHOR.

592. Magnetic Extinction of Iodine Fluorescence. O. Oldenberg. *Zeits. f. Physik*, 57. 3–4. *pp*. 186–191, 1929.

An attempt to investigate the extinction effect of magnet fields on the fluorescence of iodine vapour in the light of recent theory. The explanation of Franck and Grotrian assumes that the field shifts the maximum to the infra-red. This is confirmed by infra-red spectroscopy. It would appear that the field does not exactly extinguish the fluorescence but controls the direction of possible emission. The effect is connected with the influence on the excited state and requires a time comparable with the mean life of the excited state. J. E.

593. Carriers of Absorption and Fluorescence Bands in Cadmium Vapour. W. Kapuściński and A. Jabłoński. *Zeits. f. Physik*, 57. 9–10. *pp.* 692–695, 1929.

According to the investigations of Walter and Barratt the absorption band system (2825–2590 Å.) observed in cadmium vapour should not belong to the Cd_2 but to the CdO molecule. The present authors now show from absorption experiments with pure CdO vapour that these bands cannot be ascribed to the CdO molecules. A discussion is given of the reasons why these bands were ascribed to the Cd_2 molecule. [See also Abstract 119 (1929).] H. H. Ho.

594. Fluorescent and Phosphorescent Excitation of Mercury Vapour by Resonance Frequency and by Lower Frequencies. (Lord) Rayleigh. *Roy. Soc., Proc.* 125. *pp.* 1–23, *Aug.*, 1929.

Complete absorption is traced in a column 10 cm. long from the resonance line as far as 3750. The green visual fluorescence has been traced in dense vapours with excitation as low as 3450. The spectrum has been photographed with excitation beginning at 3360 giving broad bands 3300 and 4850. Stokes' law is thus flagrantly violated. At 10-mm. pressure the spectrum shows the line 2537 and the band 2540; at 2 mm. only the line. Excitation began at 0·66 Å. on the long wave side. When the excitation extends over the resonance line the fluorescence consists of a core effect excited by a range 0·1 Å. at resonance line and a wing effect excited by the region beyond the resonance line. These effects were examined with a moving stream of vapour. It is found that the visual core effect moves at lower stream velocity than the ultra-violet core effect, and the same applies to the wing effect. Photographs of the various phenomena are reproduced, and their bearing is discussed. J. E.

595. Phosphorescent Glow of Arsenic Flame. H. J. Emeléus. *Chem. Soc., J. pp.* 1846–1848, *Aug.*, 1929.

The conditions under which the glow of arsenic occurs has already been described by the author [see Abstract 2277 (1927)]. Since then it has been possible to photograph the spectrum of this flame and compare it with the normal flame. The spectrum of the phosphorescent flame consists of a band between 430 Å. and 490 Å., with a maximum at about 460 Å. There is close correspondence with the normal flame spectrum. With pure dry oxygen instead of air to start the phosphorescent glow the temperature at which the glow occurs is lower, but the glow is inhibited by diluting the oxygen with benzene and other organic vapours. An increase of 12° to 30° is needed to restart the glow, but it reappears at the temperature of inhibition if the normal gas flow is restarted, showing that no permanent change has occurred in the arsenic. J. E.

596. Light Emission from Phosphorescent Flames of Ether, Acetaldehyde, Propaldehyde and Hexane. H. J. Emeléus. *Chem. Soc., J. pp.* 1733–1739, *Aug.*, 1929.

This is an extension of earlier work on the ether flame [see Abstract 1360 (1927)]. The flames formed in a heated silica tube were studied spectroscopically and were found to give the same spectrum, a series of bands from 5000 to 3360 degraded towards the red. The spectrum is identical with the ether flame previously recorded, but there is no similarity with any other spectrum of similar compounds. Experiments on the reaction products showed that acetaldehyde is not completely oxidised, and that it is formed in the combustion of ether but not in the combustion of hexane and propaldehyde. The evidence at present is that acetaldehyde is not an essential intermediate product concerned with light emission. It is still quite undetermined whether the light emission is a purely adventitious effect or whether it is related to the formation of activated molecules. It is pointed out that the flames of this type always seem to give the same spectrum. J. E.

597. Ionic Impurity Content in Phosphorescent Alkali Halides. W. Koch. *Zeits. f. Physik,* 57. 9–10. *pp.* 638–647, 1929.

The absorption spectra of many phosphorescent alkali halides have been observed, but the concentration of the impurity necessary to evoke these spectra has not been measured. In this paper this gap is filled, measuring the necessary concentration by a chemical method in certain cases where thallium and lead provide the impurities. In addition, the influence of increasing concentration of the thallium content on the absorption spectra of phosphors is observed, and also the absorption spectra of the chloride and bromide of thallium and lead in aqueous solution are measured, alone and mixed with very much greater concentrations of potassium chloride in water. A. C. M.

598. Raman Spectra of Crystals. K. S. Krishnan. *Indian Journ. Phys.* 4. *pp.* 131–138, *Aug.* 1, 1929.

The author has photographed and measured the Raman spectra of quartz, calcite, topaz and selenite with an E_2 Hilger spectrograph. The table annexed gives the characteristic infra-red wave-lengths for these crystals deduced from the measurements:—

Quartz.		Calcite.		Topaz.		Selenite.	
Wave-number.	Wave-length in μ.	Wave-number.	Wave-length in μ.	Wave-number.	Wave-length in μ.	Wave-number.	Wave-length in μ.
1157	8·64	1084	9·22	1053	9·5	3493	2·86
464	21·5	771	13			3397	2·94
(?)408	24·5	279	35·8			3240	3·09
267	37·4	147	68			1134	8·81
206	48·5					1011	9·89
127	79						

Selenite which has water of crystallisation shows three sharp lines in positions corresponding to those shown by ice, and two lines of somewhat longer wave-length than the prominent line shown by solutions of sulphates in water. The values for quartz and calcite are in satisfactory agreement with those reported by Pringsheim and Rosen and by R. W. Wood respectively. AUTHOR.

599. Raman Effect in Liquids. A. S. Ganesan and S. Venkateswaran. *Indian Journ. Phys.* 4. *pp.* 195–280, *Aug.* 15, 1929.

The Raman spectra of a number of compounds, chosen to be representative of well-defined chemical types, were investigated by Raman's and by Wood's method. Both a quartz and a 2-prism glass spectrograph were used. Paraffins show a shift of 2850–2960 wave-numbers, and the band is resolved into five components. In CS_2 there is no correspondence between the Raman spectrum and infra-red absorption measurements. The characteristic differences between aliphatics and aromatics in respect to radiations about $3\,\mu$ and $10\,\mu$ are pointed out, and a shift of 1700 wave-numbers is found to be characteristic of the carbonyl group. Among inorganic compounds, sulphuric, hydrochloric and nitric acids, as well as solutions of potassium and sodium carbonates, have been examined. The effect in water and ice has been studied in detail, and the $3\,\mu$ band of water is shown to consist of three components at $2\cdot77\,\mu$, $2\cdot90\,\mu$ and $3\cdot13\,\mu$, of which the second is most prominent. A number of spectra are reproduced, and fifty-six tables of results are given. F. S.

600. Raman Spectra of Polyatomic Gases. R. G. Dickinson, R. T. Dillon and F. Rasetti. *Phys. Rev.* 34. *pp.* 582–589, *Aug.* 15, 1929.

Raman spectra of gaseous CO_2, N_2O, NH_3, CH_4 and C_2H_4 have been photographed using the line λ2536 of mercury as the exciting radiation. Vibrational transitions have been observed in all the gases investigated, and rotational transitions in the cases of NH_3 and CH_4. For the frequency shifts due to the vibrational transitions, the following numerical values (in cm^{-1}) have been found: CO_2: 1264·5, 1285·1, 1387·7, 1408·4; N_2O: 1281·8; NH_3: 3333·6; CH_4: 2914·8, 3022·1, 3071·5; C_2H_4: 1342·4, 1623·3, 2880·1, 3019·3, 3240·3, 3272·3. Raman spectra of liquid NH_3 have been photographed and found to give the two frequency shifts: 3298·4 and 3214·5. In the case of gaseous NH_3, pure rotational transitions lead to a moment of inertia having the value $I_0 = 2\cdot79 \times 10^{-40}$. In the case of methane, the positive and negative branches of the 3022·1 band lead to the value $I_0 = 5\cdot17 \times 10^{-40}$. The relations between these data and infra-red absorption data are discussed. [See also Abstract 3039 (1929).] AUTHORS.

601. Raman Spectrum of Gypsum. R. G. Dickinson and R. T. Dillon. *Nat. Acad. Sci., Proc.* 15. *pp.* 695–699. *Sept.*, 1929.

The wave-length shifts in the scattered spectrum from gypsum are tabulated, with intensity estimates. They fall into eight groups, extending from 414·2 to 3491·5 $cm.^{-1}$ on the wave-number scale. The scattered spectrum from ammonium sulphate has also been photographed, with higher dispersion. The results are discussed in the light of the known infra-red spectra and certain of the shifts are attributed to the sulphate ion and to the water of crystallisation. J. H. A.

602. Raman Spectra from Acetone. R. T. Dillon and R. G. Dickinson. *Nat. Acad. Sci., Proc.* 15. *pp.* 699–702, *Sept.*, 1929.

The scattered spectrum from acetone has been rephotographed and the shifts tabulated. Both the measurements and the interpretation differ from those of Williams and Hollaender [see Abstract 3037 (1929)]. Special attention was given to the purity of the acetone. The source of light was a glass mercury arc, with an iron arc as comparison spectrum. The number of shifted lines measured was 34, and 15 different shifts, of which 9 are accounted for in the infra-red spectrum, are required to explain them. J. H. A.

603. Raman Spectrum and Fluorescence of Benzol. C. V. Shapiro. *Nature*, 124. *p.* 372, *Sept.* 7, 1929.

All of the 51 bands given by Reimann can be arranged in series according to the general equation $V = V_0 + n'a - n''_1 b_1 - n''_2 b_2 - n''_3 b_3 - n''_4 b_4$, where n' and the n'''s are the vibrational quantum numbers of the excited and normal states respectively, and a, b_1, b_2, b_3 and b_4 are the corresponding frequencies. The value of a according to Henri is equal to 921 cm.$^{-1}$. The b levels are given, and $V = 37494$ is given by Henri as the first member of an n' progression in absorption. A series of equations represents all of Reimann's data. More than half of the fluorescence bands originate on the $n' = 2$ level, the wave-length of which in absorption, 2540 Å., is very close to the intense line at 2537 Å. in the mercury arc, the source of illumination in the fluorescence experiments. [See Abstract 2085 (1926).] T. C. H.

604. Raman Effect in Crystals. C. Schaefer, F. Matossi and H. Aderhold. *Phys. Zeits.* 30. *pp.* 581–585, *Sept.* 15, 1929.

The Raman effect in crystals of calcspar, fluorspar and quartz was investigated. A. Wahnschaff spectrometer with a 60° prism was used. The light was furnished by a mercury spectrum in which the lines with wave-lengths 4358·6, 4046·8 and 3650·2 were selected for the measurements. The results of measurements of the Raman bands were in agreement with published results. The method was used on sodium nitrate, gypsum, dilute sulphuric acid and carbon bisulphide. F. J. B.

605. Raman Lines of Solid Crystalline Sulphates and their Aqueous Solutions. A. Hollaender and J. W. Williams. *Phys. Rev.* 34. *pp.* 994–996, *Sept.* 15, 1929.

When the scattering of light takes place by crystalline solids some of the Raman lines are due to an energy change in the vibration of the crystal lattices. The Raman lines are given for the sulphates of calcium (solid), barium (solid), copper (solid and solution) and potassium-aluminum (solid and solution). All give a strong line corresponding to 10.20 μ, attributed to the sulphate ion. A. C. M.

606. Raman Effect and Hydrogen Spectrum. D. B. Deodhar. *Zeits. f. Physik*, 57. 7–8. *pp.* 570–572, 1929.

The Raman effect has been observed in the many line spectrum of hydrogen, due to the action of the ten Balmer lines on the gas molecules. The possibility of this was recently pointed out by H. S. Allen, who gave a list of a number of lines of diminished frequency, corresponding to H_α, H_β, H_γ, H_δ and H_ϵ. The author gives a Table including the effects of Balmer lines up to H_λ, the frequencies of the Raman lines are shifted in some cases to the short wave-length side of the exciting lines, and in others to the long wave-length side. These values are taken from Finkelnburg's table of hydrogen lines. The greater part of the lines with increase of frequency are found only in the new Finkelnburg table, and have very small intensity. This is to be expected, since the probability of an anti-Stokes shift is smaller than that of one in the opposite direction. H. N. A.

607. Densities of Hydrogen Spectral Lines as a Function of the Electronic Velocity of Excitation. C. J. Brasefield. *Phys. Rev.* 34. *pp.* 431–437, *Aug.* 1, 1929.

The densities of the principal lines of the singlet and triplet systems of molecular hydrogen, as well as H_α, H_β and H_γ, were measured for electronic velocities in the range 19 to 220 equivalent volts, the electron emission and the gas pressure being kept constant. The triplet lines have no maximum density in this range, but seem to be approaching one slightly below 19 volts. All the singlet lines show a decided maximum of density between 30 and 35 volts. The densities of H_α, H_β and H_γ decrease very rapidly below 30 volts, indicating that the number of dissociating collisions which produce an excited atom must be very small at 19 volts. The use of curves showing the variation in the ratio of the densities of singlet and triplet lines with voltage is suggested as a method for finding the mean electronic velocities in certain types of gaseous discharges. AUTHOR.

608. Excitation of Hydrogen Spectra by Collisions with Electrons. S. Vencov. *Comptes Rendes*, 189. *pp.* 279–280, *Aug.* 5, 1929.

Uses the method recently described by the author, with a quartz spectrograph. No lines were photographed with 11–12 volt electrons, since the corresponding bands are in the extreme ultra-violet. The continuous spectrum and secondary spectrum were obtained for voltages near the potential of ionisation of the molecule, 16·5 volts; this agrees with the results of Richardson and Tanaka and of Herzberg. The secondary spectrum obtained was formed of the strongest lines of the Fulcher bands. The continuous spectrum appeared as a homogeneous band; it is distinct from that which appears in absorption at the end of the Balmer series, in the spectra of stars. Above 16 volts, keeping the pressure below 10^{-2} mm., the intensities of the above spectra vary independently; when the pressure is raised up to 0·5 mm. the intensities increase at first, but diminish again when the free path of the molecules becomes small; the relative values of the intensities along the continuous spectrum remain constant, and the microphotometric curves are parallel to one another. The first lines of the Balmer series appear before 20 volts, which shows that it is very probable that the ionisation of the molecule at about 16·5 volts is accompanied by dissociation. H. N. A.

609. Splitting up of Hydrogen Lines in Parallel and in Crossed Electric and Magnetic Fields. N. R. Sen. *Zeits. f. Physik*, 56. 9–10. *pp.* 673–683, 1929.

Employs the theory of Dirac and Darwin to study the effect produced by combined electric and magnetic fields, the small relativity effects being neglected. When the fields are parallel the results are the same as those produced with the older form of quantum mechanics. For crossed (perpendicular) fields a diagram has been proposed showing the manner in which the H_α line is split up. H. N. A.

610. Stark Effect Intensities in the Longitudinal Effect. H. Mark and R. Wierl. *Zeits. f. Physik*, 57. 7–8. *pp.* 494–500, 1929.

The experimental method adopted is described. For the longitudinal effect observations are made parallel to the lines of force. It was found that the components of the fine structure due to the electric field, with light emission under pressure, show an unsymmetrical intensity distribution. The intensities of the long wave-length halves, when observed in the opposite direction to that of the field, are in very good agreement with Schrödinger's theory. A suggestion is made as to the reason for this result. H. N. A.

611. Second Order Stark Effect of the Balmer Lines. M. Kiuti. *Zeits. f. Physik*, 57. 9–10. *pp.* 658–666, 1929.

The second order Stark effect is determined quantitatively by the lo Surdo method in fields up to 575,000 volts per centimetre for the lines H_β and H_γ. The values are in good agreement with those calculated by quantum mechanics. A. C. M.

612. Intensity Effect of the Balmer Series in Canal Rays by Weak Magnetic Fields. S. Levy and H. R. v. Traubenberg. *Zeits. f. Physik*, 56. 7–8. *pp.* 435–440, 1929.

Magnetic fields (about 10 to 50 Gauss) caused the lines of the Balmer series in canal rays to be weakened, the effect increasing with increasing term number. The most pronounced weakening occurred for the emission component parallel to the canal ray direction, this direction and that of the magnetic field and the direction of observation being mutually at right angles. Some weakening was also observed with other arrangements of these directions. The effect is not wholly explained by the previously observed depolarisation of the canal ray luminosity by magnetic fields. [See Abstract 3092 (1927).] W. S. S.

613. Hyperfine Structure in Spectral Lines, Especially Those of Singly Ionised Praseodymium. R. C. Gibbs, H. E. White and J. E. Ruedy. *Nat. Acad. Sci., Proc.* 15. *pp.* 642–646, *Aug.*, 1929.

Observations were made in the region from 3900 to 5000 Å, using the fourth order spectrum of the 75-foot solar spectrograph on Mount Wilson, which gave a dispersion of about 1·5 Å. per cm. Nearly 200 lines exhibited complex structure, and 33 of these have been studied, the results being shown in a table. The six components of some of them show decreasing intervals and intensities towards shorter wave-lengths, and of others towards longer wave-lengths. If the fine structure observed is due to resultant angular momentum of the atom, which thus has a magnetic moment, this angular momentum must be $5/2 . h/2\pi$ in the case of the singly ionised atom of praseodymium. This angular momentum, space quantised with the resultant angular momentum of the external electrons, would cause each multiple energy level to be broken up into six components; there should then be as many as fifteen or sixteen radiated lines; only six of these would be expected to be intense. Further work is contemplated. H. N. A.

614. Extreme Ultra-Violet Spectrum of Phosphorus. P. Queney. *J. de Physique et le Radium*, 10. *pp.* 299–302, *Aug.*, 1929.

The spectrum of phosphorus, excited by a high-frequency electrodeless discharge, was photographed with a one-metre vacuum grating spectrograph. About 250 new lines have been found and measured between 1200 Å. and 2700 Å. F. S.

615. Ultra-Violet Spectrum of Magnesium Hydride: The Many-Lined γ-System. R. W. B. Pearse. *Roy. Soc., Proc.* 125. *pp.* 157–179, *Aug.* 1, 1929.

In continuation of previous work [see Abstract 2187 (1929)], the bands of the many-lined ultra-violet (γ) system of magnesium hydride have been measured in the region λ2560 to λ3240, using a large quartz spectrograph. Vibrational quantum numbers have been assigned to the bands, and the equation representing the origins shows that neither of the electron states involved is identical with any of those involved in the α- and β-systems of MgH. The rotational structure has been analysed and found to be of the simple type—one P and one R branch with one line missing at the origin—characteristic of the $'S \rightarrow 'S$ type of transition. The isotope effect was measured in the case of (0, 1) and (0, 2) bands, the observed values agreeing with the assumption of isotopes of atomic weights 24, 25 and 26. The electron levels involved in the α-, β- and γ-systems are discussed and reasons advanced for assigning the γ-system to the ionised molecule MgH^+. F. S.

616. Spectra of High-Frequency Discharge in O_2 and CO. R. W. Wood. *Phil. Mag.* 8. *pp.* 207–210, *Aug.*, 1929.

In the experiments described, highly exhausted tubes were excited externally, using a high-frequency oscillator (3-m. wave-length). The discharge was characterised by the appearance of luminous masses shaped like stream-lined bodies. Spectroscopic examination showed that these luminous masses were delineated by the light of certain band systems, showing that a molecular emission and not an atomic emission is concerned. The singly ionised carbon monoxide molecule was shown to be the source of the bands observed in the violet. A striking feature of the spectral photographs obtained was the different intensity distribution of the lines in different parts of the tube. W. S. S.

617. Absorption of Line 2537 A. by Mercury Vapour. H. Kopfermann and W. Tietze. *Zeits. f. Physik*, 56. 9–10, *pp.* 604–616, 1929.

The total absorption of the line 2537 of a well-defined resonance layer of mercury by an equal, non-luminous mercury layer, was measured by a photoelectric method. The line absorption was calculated by aid of the dependence upon the product of the maximum absorption coefficient and the thickness of the layer, and by comparison with the results of the experiments the magnitude of the value of the number of dispersion electrons for the line 2537 was obtained. F. J. B.

618. Spectrum of Mercury Arc in Atmospheres of Foreign Gases. B. Venkatesachar and L. Sibaiya. *Indian Journ. Phys.* 4. *pp.* 179–193, *Aug.* 1, 1929.

The spectrum of a mercury arc between a water-cooled anode and mercury kathode was examined, when purified gases (CO_2 and H_2) were introduced into the discharge tube to pressures ranging from 1 to 150 mm. Hg. At a pressure of 20 mm. CO_2 the lines of the series $2^3P_2 - m^3D_3$ {HgI} appeared as far as $m = 23$. The diameter of the initial orbit corresponding to the emission of the last observed member is about double the mean intermolecular distance ($2{\cdot}4\ 10^{-6}$ cm. for a pressure of 20 mm., temperature 1800° C.). It is suggested that molecules with negligible electric moments can be present inside the orbit of the optical electron without producing perturbations. By experimenting with cold and hot anodes, it was found that for a fixed pressure the replacement of Hg atoms by CO_2 molecules resulted in increased sharpness of the higher members of series lines. This might be explained if the Hg atoms link up in very loose combination, whereas no such combination between CO_2 and Hg occurs. W. S. S.

619. Densitometer Curves of the Green Mercury Line. R. W. Wood. *Phil. Mag.* 8. *pp.* 205–207, *Aug.*, 1929.

Two curves are given—one showing the true structure of the line, the other the structure as modified by absorption in a long column of luminous mercury vapour. The absorption of the various satellites is discussed, Metcalfe and Venkatesachar's observation that the satellite at −0·237 is not absorbed being confirmed. W. S. S.

620. Second Spark Spectrum of Lead, PbIII. S. Smith. *Phys. Rev.* 34. *pp.* 393–399, *Aug.* 1, 1929.

Some additional multiplets arising from combinations between triplet terms of PbIII have been found. These are $6^3P_{0,1,2} - 8^3S_1$, $6^3P_{0,1,2} - 7^3D_{1,2,3}$, $7^3P_{0,1,2} - 7^3D_{1,2,3}$ and $6^3P_{0,1,2} - pp^3P_1$. Twenty-one lines arising from combinations between singlet terms and intercombinations between singlet and triplet terms have been identified. Of particular interest is the pp^1D_2 term which is found in combination with $6^3P_{1,2}$, 6^1P_1, $6^3F_{2,3}$ and 6^1F_3. Seven newly found lines of TlII are also given, which correspond to some of the PbIII combinations classified in this paper. AUTHOR.

621. Extension of CdI-Like Isoelectronic Sequence to SbIV and TeV. R. C. Gibbs and Alice M. Vieweg. *Phys. Rev.* 34. *pp.* 400–405, *Aug.* 1, 1929.

SnIII.—New lines, in addition to those classified by Green and Loring, have been identified in this spectrum, in particular, second members of series. SbIV.—Lines have been identified arising from transitions $5s5p$ to $5s^2$; and from $5p^2$, $5s5d$, and $5s6s$ to $5s5p$. Some second members have also been found. TeV.—The CdI-like isoelectronic sequence has been extended through this element, by the classification of lines resulting from transitions between the same electronic configurations as for SbIV. [See also Abstract 2412 (1928).] AUTHORS.

622. Use of Series Inductance in Vacuum Spark Spectra. R. C. Gibbs, Alice M. Vieweg and C. W. Gartlein. *Phys. Rev.* 34. *pp.* 406–408, *Aug.* 1, 1929.

Examples are given which illustrate the effect of series inductance on the intensity and form of lines in the vacuum spark spectra of antimony and tin and its use as an aid in the identification of the lines in the spectra of these two elements. AUTHORS.

623. Excitation of Arc Spectrum of Nitrogen. O. S. Duffendack and R. A. Wolfe. *Phys. Rev.* 34. *pp.* 409–420, *Aug.* 1, 1929.

The arc spectrum of nitrogen has been quite completely excited and measured in the region 8800–3400 Å. with a low voltage arc in a mixture of helium and nitrogen. The process of excitation is probably a two-step process: the first being the dissociation of nitrogen molecules into neutral atoms by impacts of the second kind with metastable helium atoms, and the second being the excitation of neutral nitrogen atoms by second impacts with metastable helium atoms. A complete list of wave-lengths is given and the classifications of the lines designated as far as they are known. A considerable number of new lines have been classified. AUTHORS.

624. Classification of Arc Spectra of Nitrogen and Carbon. S. B. Ingram. *Phys. Rev.* 34. *pp.* 421–430, *Aug.* 1, 1929.

A carbon arc in air run at 125 amperes served to produce the arc spectra of carbon and nitrogen with great intensity. Using an infra-red spectrometer with a plane grating and a vacuum thermopile the wave-lengths and approximate intensities of about 125 lines between 9000 Å. and 20,000 Å. have been measured. About 90 of these lines are classified as combinations between terms in carbon I and in nitrogen I. A number of new terms are fixed in both of these spectra, and many of the terms provisionally identified by Fowler and Selwyn in CI and by Compton and Boyce in NI are definitely confirmed. Using data obtained by Duffendack and Wolfe a number of lines have been classified in the visible spectrum of nitrogen I. Reasons are given for changing the previous designations of the ^2P and ^2D terms found by Kiess at 5100 and 6800 respectively. These are assigned to the $2s^2 2p^2 . 3p$ configuration and are considered as being based on the ^1D term of nitrogen II. A complete term table of nitrogen I is given. AUTHOR.

625. Arc Spectrum of Chlorine. K. Majumdar. *Roy. Soc., Proc.* 125. *pp.* 60–67, *Aug.* 1, 1929.

Examines both theoretically and experimentally the arc spectrum of chlorine, previously only partially investigated. Using the method of horizontal comparison in the location of spectra of elements, as stated by Saha and Majumdar [see Abstract 176 (1929)], the location of the group representing the transition $4M_2\ (N_1 \leftarrow N_2)$ is obtained, it being shown that these lines should be expected to lie in the region λ9300–7700. Laporte's classification of the group at λ4700–4200 being due to $4M_2\ (N_1 \leftarrow N_2)$ is, therefore, wrong and should be identified with the transition $4M_2\ (M_1 \leftarrow O_2)$. The chlorine arc spectrum was photographed in the region λ8700–6400, and the lines obtained identified as belonging to the transition $4\ M_2\ (N_1 \leftarrow N_2)$, thereby proving the theoretical conclusion. A table of the lines obtained is given in which it is shown that lines in the region mentioned by Laporte do definitely belong to the $4M_2\ (N_1 \leftarrow O_2)$ transition. From the new results the ionisation potential of chlorine is found to be 13·1 volts, whilst a comparison with solar wave-lengths does not definitely prove that these infra-red lines of chlorine occur in the sun. R. C. F.

626. Zeeman Effect for the Arc Spectrum of Gold. A. S. M. Symons and J. Daley. *Phys. Soc., Proc.* 41. *pp.* 431–441, *Aug.* 15, 1929.

The Zeeman effect for about 50 gold lines has been observed and recorded. The field strength used was about 23,000 gauss. A former assignment of terms to the AuI spectrum by McLennan and McLay [see Abstract 141 (1927)] has been verified to some extent, but certain modifications have been suggested. Suggestions have also been made as to the identity of a few terms which were not previously identified. AUTHORS.

627. Intensities in the Harmonic Band of Hydrogen Chloride. J. L. Dunham. *Phys. Rev.* 34. *pp.* 438–452, *Aug.* 1, 1929.

The intensities of the first nine lines of the negative branch of the first harmonic absorption band of HCl at $1.76\,\mu$ have been measured with a prism spectrograph, using a galvanometer and thermo-relay to observe thermopile voltages. The positive branch, not being resolvable, was measured as a whole. The areas under the lines in a plot of per cent. absorption against frequency were obtained for 5 different tube lengths, namely 74·5, 25·0, 14·96, 9·90 and 4·88 cm. and the integrated absorption coefficient of each line was calculated from the slope of the curve of area against tube length at the origin by methods developed by Bourgin. The probable error of the intensity measurements for the stronger lines was 6 %. A calculation is made of the intensity ratio of the band as a whole to that of the fundamental based on a solution of Schrödinger's equation obtained by Morse for an anharmonic oscillator, and the value so obtained is within 6 % of the experimental value. A second order perturbation calculation based on harmonic oscillator functions did not give concordant results. An unpublished analysis of the effect of rotation on the relative intensities of the lines in a band by Kemble is given and the relative intensities calculated for this band, giving agreement with experiment within 5 %. AUTHOR.

628. Dispersion and Absorption Line Width in Alkali Vapours. S. A. Korff. *Phys. Rev.* 34. *pp.* 457–462, *Aug.* 1, 1929.

Measurements were made photographically at various vapour densities of the widths in absorption of the sodium D lines, and of rubidium 4201 and 4215. Stewart's line width equation was again verified, indicating that scattering produced the opacity at the edges of absorption lines at low vapour densities. This equation has not previously been directly tested for higher series members. Photographic measurements of the refractivity of sodium vapour near the D lines were made, and increased precision obtained over the visual measurements previously reported. The dispersion is found to conform to the classical curve, within an experimental error of 1 %. The form of the dispersion to line width relation is shown to remain unchanged for higher series members. A theoretical treatment of the line width equation is given, indicating the modifications which quantum theory introduces. The form of the equations remains unchanged, but the number of molecules active in scattering is made explicit. "Negative line width" is introduced, corresponding to the negative term in the dispersion formula, but the correction would be small except at high temperatures. AUTHOR.

629. Additional Series Lines in Spectra of CII and NII. I. S. Bowen. *Phys. Rev.* 34. *pp.* 534–536, *Aug.* 1, 1929.

Several of the strong lines of CII have been identified as combinations of the ^{4}P term of the sp^2 configuration with the quartet terms observed by Fowler and Selwyn. This fixes the term values $^4P_1 = 206810\cdot 7$, $^4P_2 = 206789\cdot 2$, $^4P_3 = 206760\cdot 6$. In NII the term value of the ^{1}S term of the s^2p^2 configuration has been fixed at 206159, and of the ^{1}P term of the sp^3 configuration at 72084 relative to the term values given by Fowler and Freeman. The ^{1}S term combines with the ^{1}D term of the same configuration to give the nebular line at 5754·8 Å. A large number of terms including those which Fowler and Freeman designated by "*a*" have been shown to belong to the quintet system. The relative term values of these are given. AUTHOR.

630. Spark Spectrum of Thallium, TlIII. J. C. McLennan, A. B. McLay and M. F. Crawford. *Roy. Soc., Proc.* 125. *pp.* 50–53, *Aug.* 1, 1929.

The term structure for Tl III advanced by Carroll is shown by recent work by the authors to be untenable. A fresh analysis is here put forward based in part on new measurements. The classifications of twenty-two lines of Tl III are listed, ranging from λ8001 to λ1231. W. S. S.

631. New Zinc Hydride Bands in the Ultra-Violet. E. Bengtsson and B. Grundström. *Zeits. f. Physik*, 57. 1–2. *pp.* 1–10, 1929.

New bands for zinc hydride were found between the wave-lengths 2500 Å. and 2000 Å., and the structure of five of these bands examined. It is shown that, considering their simple P^- and R^- sections, they represent a ${}^1\Sigma' \rightarrow {}^1\Sigma$ electron jump of an ionised Zn^+ H dipole. The combination relations are examined, and from these relations the constants of the beginning and end conditions are obtained, whilst an end scheme of the system is given and the dissociation energy calculated. Finally, the authors discuss the intensity distribution in the bands and attempt to draw conclusions regarding the causes of the band production. R. C. F.

632. Properties of a Class of Molecular Terms, Particularly Terms of the Helium Molecule. G. H. Dieke. *Zeits. f. Physik*, 57. 1–2. *pp.* 71–105, 1929.

Investigates the rotational structure of the terms of a molecule, when the influence of the characteristic rotation of the electrons can be neglected. Follows the passage from stronger to weaker rotation, or from weaker to stronger coupling of the orbital impulse of the electrons, by means of a perturbation calculation on the lines of Hill and van Vleck. Formulæ are obtained which represent approximately the energy of a molecule even in the transitional stages. The results are applied to terms found in the band spectrum of helium; some of these have the orbital impulse of the electrons very strongly coupled to the line joining the nuclei, while in others it is almost uncoupled. There is in general good agreement with theory. The distribution of intensity in the bands, which is often apparently anomalous, receives a satisfactory explanation. [See Abstract 2938 (1929).] H. N. A.

633. New Regularities in the Band Spectrum of Helium. Part III. G. H. Dieke, S. Imanishi and T. Takamine. *Zeits. f. Physik*, 57. 5–6. *pp.* 305–325, 1929.

Continuing previous work [see Abstracts 3016 (1928) and 3042 (1929)], the bands corresponding to combinations of the 4*s*, 5*s*, 6*s*, 4*d*, 5*d*, and 6*d* terms with a new end term are assigned. The end term 2*s'* is interpreted as $2\pi^3\Sigma$, and is analogous to the B state of the hydrogen molecule. In addition, more bands are given having the 2*p* state as final state. W. S. S.

634. Ultra-Violet Dispersion Frequencies of Alkali Halides. R. Hilsch and R. W. Pohl. *Zeits. f. Physik*, 57. 3–4. *pp.* 145–153, 1929.

Gives frequencies observable in air and also a consideration of energy by means of which the first ultra-violet energy levels can be calculated with sufficient approximation. The work is based upon the experimental fact that the light absorption at the first level involves the elementary photographic process. E. E. F. d'A.

635. Higher Spark Spectra of Neon and Argon in the Extreme Ultra-Violet. J. C. Boyce and K. T. Compton. *Nat. Acad. Sci., Proc.* 15. *pp.* 656–658, *Aug.*, 1929.

An electrodeless ring tube was used attached to the slit of the vacuum spectrograph by a side tube. With neon the strongest lines were those due to NeIII, with NeII and NeIV less intense and NeI practically absent. Selective ionisation was possible, lower pressure and higher power favouring higher stages of ionisation. The lowest ionisation limit (of NeIII, corresponding to the $s^2p^3\,{}^4S^0_{1\frac{1}{2}}$ state of NeIV) was found to be 511,700, or 6·3 volts; less complete analysis of ArIII gave a tentative lowest ionisation limit of 329,500 or 40·7 volts. A table gives the wave-length and initial and final terms of a number of lines of NeIII, NeIV, ArIII and ArIV. Further study of the spectra of Ne and Ar in the region between λ2200 and λ1300 will be required to connect the results with those obtained in the visible and near ultra-violet regions. A new vacuum spectrograph of greatly increased range and dispersion is being constructed, which should make this possible. H. N. A.

636. Afterglow in Glow Lamps Filled with Neon, Argon and Neon-Argon Mixtures. M. J. Druyvesteyn. *Zeits. f. Physik,* 57. 5–6. *pp.* 292–304, 1929.

The afterglow in glow lamps filled with neon, argon and neon with 0·5–3 % argon has been studied visually and spectrographically. Since the spectrum of the afterglow is generally a recombination spectrum, it is possible by comparison with the spectrum of the principal discharge to determine whether the latter is an activation or recombination spectrum. The discharge in pure neon gives lines due to both atoms and ions. The strongest lines are the red arc lines 1*s*–2*p*. As far as the afterglow is concerned these lines may be divided into three groups: (1) lines which do not appear in the afterglow; (2) the arc lines 1*s*–2*p*, which appear weaker in the afterglow for 6.10^{-4} sec.; (3) other arc lines which first increase in intensity immediately the potential is switched off, and then decrease. The spectra of the principal discharge and afterglow in argon are similar to those observed in neon. In glow lamps with argon and neon the neon lines are confined to the discharge, while argon lines appear in the aurora. The neon lines in the discharge and in the afterglow are very similar to those obtained in pure neon. It is concluded (1) that the discharge in argon gives rise to an activation spectrum; (2) that the argon spectrum from the aurora in tubes containing argon and neon is a recombination spectrum; and (3) that the afterglow both in argon and in argon and neon mixtures gives a recombination spectrum. F. J. W.

637. Forbidden s–d Transitions in Alkali Metals. W. Prokofjew. *Zeits. f. Physik,* 57. 5–6. *pp.* 387–393, 1929.

The metal was heated in an iron tube 70 cm. long and the anomalous dispersion observed by means of an interferometer and glass spectrograph. The transition probability of the forbidden 1*s*–3*d* lines is found to be of the order 10^{-5} to 10^{-6}. The probability of the 1*s*–4*d* line of C*s* is found to be about the same. The intensity ratio of the components of the 1*s*–3*d* doublet of C*s* is 1·4 to an accuracy of 10 %. F. S.

638. Theory of Intermittent Action and Series Spectra. K. C. Kar. *Zeits. f. Physik,* 57. 5–6. *pp.* 416–428, 1929.

Describes a new viewpoint from which Bohr springs from one atomic level to another can be considered, based on the theory of intermittent action which the author has developed in previous papers. A general agreement is found between the resulting theory and that of S. C. Kar. It appears to lead to a more general formula for series spectra than other theories such as that of Sommerfeld; when relativity is taken into account the fine structure of spectra can be explained. H. N. A.

639. Nature of the Resting Mass of Light Quanta. G. I. Pokrowski. *Zeits. f. Physik,* 57. 7–8. *pp.* 566–569, 1929.

Suggests that the resting mass of light quanta may be of electrostatic origin. In that case it should be possible, by measuring the deviation of light in the magnet field of the sun, to obtain the value of e/m_0 for quanta. Making use of the measurements of light deflection made by Campbell and Trumpler in the 1922 solar eclipse in the neighbourhood of the sun's magnetic pole, it can be shown that the charge of the quantum is positive, and that the ratio e/m_0 is equal to that of protons. The question requires further investigation. H. N. A.

640. New Ultra-Violet Cadmium Hydride Bands. E. Bengtsson and R. Rydberg. *Zeits. f. Physik*, 57. 9–10. *pp*. 648–657, 1929.

New bands of cadmium hydride have been found between 2700 and 2200 Å., and the conditions for their excitation investigated. The bands consist of simple P and R branches, and the system of bands is attributed to an electron jump $^1\Sigma^1 \rightarrow {}^1\Sigma$ of ionised cadmium hydride. The nuclear vibration formula and the constants of the band system are given. The intensity distribution is discussed, and the energies of dissociation of the two electronic states and the ionisation energy of the neutral molecule are calculated. A. C. M.

641. Zeeman Effect and Superfine Structure in the Antimony Arc Spectrum. H. Löwenthal. *Zeits. f. Physik*, 57. 11–12. *pp*. 822–834, 1929.

The Zeeman effect for eighteen lines of antimony iodide is given and confirmation thereby afforded to the term order of McLennan and McLay, which was in agreement with the previous prediction of Hund. From the Zeeman effect it is deduced further that antimony does not fit in with the Russell–Saunders scheme. The presence of a superfine structure is established for the term $p^2P_{1/2}$, whereby the Green and Loring disproof of the *g*-summation rule is explained. The results are extended for the already known combination scheme of the infra-red lines. H. H. Ho.

642. Regularities in the Arc Spectrum of Arsenic. K. R. Rao. *Roy. Soc., Proc.* 125. *pp*. 238–246, *Aug.* 1, 1929.

Describes measurements on the arsenic arc spectrum in the region $\lambda 8800$ to $\lambda 1370$, a number of previously unrecorded lines being included, which lead to the identification of combinations between the deepest set of terms, $4p^4S$, ^2D, ^2P, and the higher $5s$ and $4p'$ terms. Combinations with some of the terms of the $4d$ state are also suggested. The resonance triplet is found to correspond to the combination $4p^4S-5s^4P$. A catalogue of lines for the As arc spectrum, with the classification where possible, is appended. W. S. S.

643. AsIII Spectrum. A. S. Rao and A. L. Narayan. *Zeits. f. Physik*, 57. 11–12. *pp*. 865–868, 1929.

The spectra obtained from arsenic under different conditions of excitation contain many lines which are to be ascribed to AsIII. These lines are classified. It is found that they contain the strong quartet terms predicted by the theory of Hund. F. J. W.

644. Band Spectrum of Lanthanum Monoxide. W. Jevons. *Phys. Soc., Proc.* 41. *pp*. 520–544; *Disc.*, 545, *Aug.* 15, 1929.

From observations on the band spectrum of lanthanum monoxide between $\lambda 2850$ and $\lambda 8700$, the author has obtained the positions of the band heads, most of which have not previously been recorded, and has arranged them into their several systems. From a comparison of the results obtained with those of Auerbach, giving details of most of the band heads in the two infra-red groups, and Mecke, who obtained seven band systems from a vibrational analysis [*Naturwissenschaften*, 17. pp. 84 and 86, Feb. 1, 1929], it is shown that certain of Mecke's conclusions may be regarded as correct. The others appear contradictory, depending upon the interpretation of the results. Mecke analysed the seven systems to have 0,0 bands at (1) λ4372, (2) λ4418, (3) λ5600, (4) λ7380, (5) λ7404, (6) λ7877 and (7) λ7910. The conclusions of Mecke, supported by the present author's results, are that the systems (3), (5) and (7) have a common final state. The author disagrees with Mecke's analysis of system (2), the 1,2 band of the author's being the 0,1 band in Mecke's results. If the present analysis is correct, then Mecke's conclusions that systems (1) and (2) have a common final state, and also that the initial states for (1) and (2) appear to be the final states of (4) and (6) respectively, cannot be correct. If the theory that systems (1) and (2) have a common final state is correct, then any states of these two systems common with systems (4) and (6) must be the final states in each case. Systems (4) and (6), which appear very much alike, are examined in more detail to ascertain whether they possess common initial or final states, whilst some ultra-violet bands degraded in the opposite direction to systems (1) to (7) are examined, although no complete system can be traced from the results obtained up to the present. Finally, a brief note on the general theory of electronic band spectra of diatomic molecules is given. R. C. F.

645. New Terms in the Spectra of AlI, GaI and InI. W. D. Lansing. *Phys. Rev.* 34. *pp.* 597–598, *Aug.* 15, 1929.

The spectra of Al, Ga and In were investigated in a tungsten vacuum furnace. Lines arising from the term $sp^2\,{}^2D$ were discovered in AlI. A^2P–^4P combination was found in InI from previous data. AUTHOR.

646. Influence of Foreign Gases on Intensities of Magnesium Resonance Lines 4571 and 2852. J. G. Frayne. *Phys. Rev.* 34. *pp.* 590–596, *Aug.* 15, 1929.

The Mg line 4571, 3^1S–3^3P_1, is very weak in the arc, while 2852, 3^1S–3^1P, is very intense. The life of the 3^3P_1 state is calculated to be 4×10^{-3} sec., while 3^1P has a life of 3×10^{-9} sec. Collisions of second kind between excited Mg atoms reduce intensity of 4571 in the arc. At a vapour pressure of 10^{-4} mm., the time between collisions of the Mg atoms is 10^{-3} sec. The 4571 line should appear strong at this or lower vapour pressures. Vapour from solid Mg metal at 500° C. was excited in an evacuated tube by an electrodeless short-wave discharge. The 4571 line appeared in the discharge as a fairly prominent line. The noble gases enhanced this line, the intensity relative to the triplet 3838 increasing up to about 20 mm. in argon and 10 mm. in neon and helium, and then remaining practically constant. At these pressures, argon increased the line 100 times, Ne about 70 times, and He about 40 times. N_2 and CO increased 4571 up to the limit of pressure, about 2 mm., at which the discharge could be operated. H_2 caused a slight increase at a pressure of about 2 mm. Intensity-pressure curves for noble gases have been reproduced theoretically, proving the assumption that excited Mg atoms suffer collisions of the second kind with the walls, and that action of a noble gas in enhancing the 4571 line is due entirely to the slowing up of diffusion of Mg atoms in 2^3P_1 state to the walls, and to its inefficiency in causing collisions of the second kind with excited Mg atoms. All gases reduce 2852 and all singlets terminating on the 3^1P level. Increasing pressure of H_2 reduces 2852 faster than the singlets. Dissociation of the H_2 molecules by Mg atoms in 3^1P state reduces radiation from that state. AUTHOR.

647. Infra-Red Absorption Spectra of Organic Nitrates. E. K. Plyler and P. J. Steele. *Phys. Rev.* 34. pp. 599–603, *Aug.* 15, 1929.

The infra-red absorption of four organic nitrates has been studied in the region from 1·0 to 7·5μ. The liquids used are methyl nitrate, ethyl nitrate, propyl nitrate and butyl nitrate. Two absorption bands at 1·40μ and 2·96μ are attributed either to an OH linkage or water. All other bands are attributed to the carbon-hydrogen linkage, and as an additional CH_2 group is introduced, two characteristics appear, namely, the intensity of all bands decreases, and a shift of from 0·01 to 0·06μ to longer wave-length occurs. No characteristic absorption spectra of the NO_3 group have been found to exist in the organic nitrates. Previous workers have found that the carbon-hydrogen linkage gives regions of intense absorption at about 3·43, 6·86, 8 to 10 and 12 to 18μ. In the present work an intense band was observed at 6·7μ, but the observations were not carried past 7·5μ, and the other two fundamental frequencies were not observed. However, from observed bands there have been calculated four regions of intense absorption, which are assumed to be the fundamental frequencies, and all other bands observed are attributed to a combination or overtones of these fundamentals. AUTHORS.

648. Infra-Red Absorption Spectrum of Hydrogen Sulphide. A. H. Rollefson. *Phys. Rev.* 34. *pp.* 604–610, *Aug.* 15, 1929.

The infra-red absorption bands of hydrogen sulphide in the regions of 4·2, 5·6 and 8·0μ were investigated by means of a prism-grating spectrometer. A narrow, intense absorption band was observed at 4·2μ, but could not be resolved. The 5·6μ band observed by Coblentz was not found. Evidence is presented to show that the band observed by Coblentz might have been due to an impurity. Thirty-four lines of the band in the region of 8·0μ were observed. AUTHOR.

649. Band Systems of Titanium Oxide. Frances Lowater. *Phys. Soc., Proc.* 41. *pp.* 557–567; *Disc.*, 567–568, *Aug.* 15, 1929.

The bands of TiO have been found to extend toward the infra-red through some 800 Å. further than the range previously known. Bands in the orange, red and infra-red regions have been analysed into two systems, distinct from the blue-green system. One of these is due to the transition $^1\Pi \rightarrow {}^1\Sigma$, the other to $^3\Sigma \rightarrow {}^3\Pi$, the latter having the same final energy level as the blue-green system $^3\Pi \rightarrow {}^3\Pi$. Analysis of other bands in the red is in progress. AUTHOR.

650. Absorption Spectrum of Bromine Vapour. Margaret B. Hays. *Frank. Inst., J.* 208. *pp.* 363–369, *Sept.*, 1929.

Light from an incandescent lamp was passed through a column of bromine vapour 80 cm. long and photographed with a 14-ft. concave Rowland grating. Results from 6117 Å. to 6309 Å. are tabulated. Two band heads located by Nakamura at 6200 Å. and 6210 Å. are shown not to be heads, but one at 6150 Å. is confirmed. Curves of the bands indicate that they consist of P and R branches, but that there is no Q branch. F. S.

651. Line Absorption Spectra of Solids at Low Temperatures in the Visible and Ultra-Violet Regions. Preliminary Study of Gadolinium Chloride Hexahydrate. S. Freed and F. H. Spedding. *Phys. Rev.* 34. *pp.* 945–953, *Sept.* 15, 1929.

The absorption spectrum of gadolinium chloride hexahydrate, $GdCl_3, 6H_2O$, has been examined from 2000 Å. to 6000 Å. at the ordinary temperature and at the temperatures of liquid air and hydrogen. About ninety lines were measured, almost all in the ultra-violet, and all sharp, even at the ordinary temperature. As temperature falls there is a slight general shift towards the red, and greater separation in lines of the same multiplet, due to contraction of the crystal. There are many indications of multiplets with constant frequency intervals. A new method of growing crystals is described, whereby the crystals used, measuring up to 1·5 × 1·0 cm., were grown in two to four days. C. A. S.

652. Ultra-Violet Absorption of the Carbonyl Group. K. L. Wolf and W. Herold. *Zeits. f. phys. Chem.* 5. *Abt. B.* 2. *pp.* 124–130, *Sept.*, 1929.

Absorption measurements with saturated aliphatic and hydro-aromatic ketones show that, of the two ultra-violet absorption bands observed with these compounds in organic solvents and in water, those corresponding with the longer wave-length ($\lambda_{max.}$ at about 2600–3000 Å.) have for $k_{max.}$ the value about 1·2–1·4. The values of $k_{max.}$ for the first ultra-violet absorption bands of the carbonyl group in acids, ketones and aldehydes are discussed, and a new series of values for the ketones is given. The results previously obtained for propaldehyde show that the aldehyde bands exhibit normal behaviour. The fact that earlier results obtained with alcoholic solutions pointed to abnormal behaviour is attributed to reaction between the alcohol and aldehyde; such reaction may be followed optically. The formation of aldehyde hydrates, semi-acetals and acetals may be traced by investigation of the ultra-violet absorption. T. H. P.

653. CH-Band at λ3143 and New NH-Band at λ2530. T. Hori. *Nature*, 124. *p.* 480, *Sept.* 28, 1929.

From the general characteristics of the CH-band with intensity maximum at λ3143, observed with a condensed spark discharge between tungsten and carbon electrodes in hydrogen, it appears to belong to a $^2\Sigma \rightarrow {}^2\Pi$ system. The nuclear distance in the $^2\Sigma$ state is $r = 1\cdot 12 \times 10^{-8}$ cm. With a similar discharge and a lithium electrode in place of tungsten, in a mixture of nitrogen and hydrogen, a new simple band at λ2530 is observed. Analysis shows its emitter to be the NH-dipole and the corresponding transition of $^1\Sigma \rightarrow {}^1\Pi$ type. The nuclear separations of the molecule in its initial and final states are $r = 1\cdot 03 \times 10^{-8}$ cm. and $r' = 1\cdot 06 \times 10^{-8}$ cm. respectively. A. J. M.

654. Super-Multiplet Intensities in the Titanium Spectrum. G. R. Harrison. *J.O.S.A. and R.S.I.* 19. *pp.* 109–133, *Sept.*, 1929.

Intensity measurements have been made on a complex super-multiplet of normal titanium, $^5D'FG' - {}^5H'GF'D'P'$, arising from the transition $[(3d)^2 4s]4p - 4d$, and on a simple super-multiplet, $^5D'FG' - {}^5F'$, arising from the transition $[(3d)^2 4s]4p - 5s$. The intensities in the latter are nearly normal, being within 6 % of theoretical values. The complex multiplet has extremely anomalous intensities. Very few lines have normal intensity ratio to one another, and in no multiplet is the sum rule fulfilled. The average deviation of the sums from the mean is about 15 % after an excitation correction of 2080 Å. for the temperature of the arc. F. S.

655. Molecular Spectra and Molecular Structure. *Faraday Soc., Trans.* 25. *pp.* 611–690, *Nov., and pp.* 691–949, *Dec.,* 1929.

A treatise on the subject comprising thirty-eight papers and discussions by various contributors arranged under three main headings, with a "General Introduction" and a final "Summary" by **W. E. Garner** and **J. E. Lennard-Jones,** as follows:—

Part I.—Band Spectra in the Visible and Ultra-Violet Regions.—"Nomenclature and Symbolism for the Spectra of Diatomic Molecules," by **O. W. Richardson;** "Band Spectra and Atomic Nuclei," by **R. S. Mulliken;** "Chemical Binding," by **F. Hund;** "Detailed Electronic Structure of Diatomic Molecules, with Special Reference to CO," by **R. C. Johnson;** "Electronic Structure of Some Diatomic Molecules," by **J. E. Lennard-Jones;** "Electronic Levels of H_2," by **O. W. Richardson;** "Band Spectrum of Helium," by **W. E. Curtis;** "Determination of Heats of Dissociation by Means of Band Spectra," by **R. T. Birge;** "Absorption Spectra of Methyl Halides and other Methyl Compounds in the Ultra-Violet and Schumann Region," by **G. Herzberg and G. Scheibe;** "Isotopes in Band Spectra," by **R. T. Birge;** "Isotope Effect in Absorption Spectrum of Iodine Monochloride," by **J. Patkowski and W. E. Curtis;** "Recombination Spectra of Halogens and Probability of Molecular Formation from Atoms," by **V. Kondratjew and A. Leipunsky;** "Absorption Spectrum of Chlorine Dioxide," by **C. F. Goodeve and C. P. Stein;** "Band Spectra and Electronic States of Some Metal Hydrides," by **E. Bengtsson and E. Hulthén;** "Spectra of Metal Molecules," by **S. Barratt;** "Visible Absorption Spectra in Crystalline Salts of Rare Earths," by **F. I. G. Rawlins;** "Absorption Spectra of Polyatomic Molecules," by **V. Henri.** *Discussion* by **J. Errera, J. E. Lennard-Jones, G. H. Dieke, W. Jevons, R. Mecke, V. Henri, O. S. Duffendack, R. S. Mulliken, G. Herzberg, C. P. Snow, H. G. Grimm, R. C. Johnson, E. B. Ludlam, H. Volkringer, V. Kondratjew, W. E. Curtis, C. F. Goodeve.**

Part II.—Raman Effect.—"Molecular Structure by Light Scattering," by **C. V. Raman;** "Excitation of Raman Spectra," by **R. W. Wood;** "Raman Effect with Liquid Oxygen, Nitrogen and Hydrogen," by **J. C. McLennan;** "Degradation of Light Frequencies by Molecular Scattering," by **J. Cabannes;** "Polarisation of Raman Radiations in Liquids and Crystals," by **J. Cabannes;** "Raman Effect in some Liquified Gases," by **P. Daure;** "Raman Lines in Spectrum of Electric Discharge," by **H. S. Allen;** "Raman Effect of Some AX_4 Groups," by **A. M. Taylor;** "Plane Polarisation of Raman Spectra and Raman Lines Scattered from Coarsely Powdered Crystals," by **A. C. Menzies.** *Discussion* by **V. Henri, O. W. Richardson, H. G. Grimm, C. Schaefer, T. M. Lowry, R. Mecke, J. Errera, W. E. Garner.**

Part III (*a*).—Infra-Red Spectra of Solid Bodies.—"Introductory Paper," by **C. Schaefer;** "Infra-Red Absorption Spectra of Salts Containing the Group AX_4," by **A. M. Taylor;** "Band Spectrum of $KMnO_4$ in the Crystalline State and in Solution," by **A. M. Taylor.** Part III (*b*)—Infra-Red Spectra of Liquids.—"Introductory Paper," by **J. Lecomte;** "Infra-Red Bands of Hydrogen Combined with Carbon in the Molecule of Organic Compounds," by **G. B. Bonino**; "Molecular Absorption Spectra of Liquids below 3 μ," by **J. W. Ellis.** Part III (*c*).—Infra-Red Spectra of Gases.—"Introductory Paper," by **R. Robertson**; "Infra-Red Spectra of Gases under High Dispersion," by **E. F. Barker and C. F. Meyer**; "Chemical Structure and Infra-Red Analysis," by **E. K. Rideal**; "Form of the Molecule of Carbon Dioxide," by **F. I. G. Rawlins**; "Probable Infra-Red Spectrum of Sulphur Vapour," by **A. M. Taylor**; "Vibration-Rotation Spectra of Diatomic Molecules," by **C. P. Snow**; "Absorption Spectrum of Ammonia Gas in the Near Infra-Red," by **R. Mecke and R. M. Badger.** *Discussion* by **H. G. Grimm, E. F. Barker, R. Robertson, O. S. Duffendack, C. P. Snow, J. Errera, R. Mecke.**

656. Reflection and Absorption of X-Rays. M. A. Valouch. *Comptes Rendus*, 189. *pp*. 283–285, *Aug*. 5, 1929. *Phys. Zeits*. 30. *p*. 911, *Dec*. 1, 1929.

The index of refraction of X-rays being less than unity, $= 1 - \delta$, we obtain total reflection of angles of incidence less than $\theta = \sqrt{2\delta}$. The author has found a method for ascertaining, by means of an appropriate ionisation chamber, the values of the reflecting powers of different mirrors for X-rays of wave-lengths of some tens of Å. units. The reflecting power is not constant throughout the range of total reflection, but falls off rapidly as the angle of incidence increases. The curve of angles of incidence and reflecting powers is traced. It is then sought, by the Fresnel–Prins formula [see Abstract 1624 (1928)], to find what value of θ must be used with known coefficients of absorption to give a curve corresponding to the experimental curve. In this way the index of refraction and the coefficient of absorption are found together. In this way the coefficient of absorption has been found for mirrors as absorbent as lead glass for X-rays of great wave-length. A. D.

657. Influence of X-Rays on Absorption of Alkali Halogen Phosphors. Agnes Arsenjewa. *Zeits. f. Physik*, 57. 3–4. *pp*. 163–172, 1929.

The sharp absorption bands are in the case of lead containing phosphors weakened, with thallium phosphors strengthened. At the same time the short-wave member of the two bands shifts towards the violet, and in many cases the bands split up. There is in addition a broad band brought in by the X-rays which moves farther and farther into the violet with continued exposure, and which overlaps the sharp bands. This absorption comes in slowly, in the course of days. All these effects are independent of whether the observations are made on a phosphor which is coloured before or by the radiation. J. E.

658. Satellites of X-Ray Lines Lα, Lβ_1 and Lβ_2. F. K. Richtmyer and R. D. Richtmyer. *Phys. Rev*. 34. *pp*. 574–581, *Aug*. 15, 1929.

The satellite structure accompanying the X-ray diagram lines *L*α, Lβ_1 and Lβ_2 has been investigated for the elements (Rb(37) to Sn(50). This structure is more complex than has heretofore been assumed. Not only is the number of satellites greater than previously reported, but a continuous spectrum seems to extend for some distance toward shorter wave-lengths beyond the satellites. Tables are given showing wave-lengths, values of ν/R and of $\Delta\nu$/R ($\Delta\nu$ = difference in frequency between satellite and parent line) for five (seven for some elements) satellites of

$L\alpha$, four of $L\beta_1$, and five of $L\beta_2$. The empirical relation previously reported for the $K\alpha$ satellites is found to hold for these L satellites: namely, the square root of the difference in frequency between a satellite and its parent line is a linear function of atomic number—similar to Moseley's law for diagram lines. The difficulties of obtaining values of the wave-lengths of satellites as accurate as are the measured wave-lengths of the corresponding diagram lines are discussed. It is shown that some of these difficulties may be eliminated by obtaining a densitometer curve for the energy distribution through the parent line at a voltage just below the excitation voltage of the satellites. From measurements on a plate taken at high dispersion it appears that satellites may be resolved into fine-structure components. AUTHORS.

659. Bending of X-Rays in a Very Thin Crystal Plate. W. Linnik. *Zeits. f. Physik*, 57. 9–10. *pp.* 667–668, 1929.

It has been shown that the phenomena observed can be explained to a first approximation as due to a two-dimensional lattice. This, however, does not give a full explanation of the observations. As a matter of fact, thin mica plates, which have been split up by heating and give the effect in question, are considerably bent. The X-rays fall on a large number of thin plates, making various small angles with one another, the orientation of the normals being irregular. This destroys the Laue effect, since the Laue spots are very sensitive to a turning of the crystal. The Bragg effect, however, will persist in such a way as to give much the same result as a two-dimensional lattice. When an ordinary mica plate is slowly turned round a vertical axis, and at the same time subjected to rapid vibrations about the horizontal axis, the diffraction image produced by a beam of X-rays is almost the same as that produced by the split-up mica plate. H. N. A.

660. X-Ray Diffraction from Crystalline Aggregates. S. B. Hendricks. *Zeits. f. Krist.* 71. 3. *pp.* 269–273, *Aug.*, 1929.

The X-ray diffraction patterns from natural crystals of kaolinite and heated mica have been examined. The characteristics of these patterns can be explained as due to a space lattice diffraction from a micaceous crystalline mass, in which the crystals diverge slightly from being parallel to the cleavage surface, but are not rotated about the normal to the surface. Evidence is brought forward to show that the patterns cannot arise from a system of superimposed two-dimensional gratings as suggested by Linnik [*Nature*, 123. *p.* 604, April 20, 1929]. F. J. W.

661. X-Ray Diffraction by Amorphous Solids. P. Krishnamurti. *Indian Journ. Phys.* 4. *pp.* 99–108, *Aug.* 1, 1929.

The change from the amorphous solid to the liquid state is accompanied by anomalous rate of thermal expansion, specific heat and thermal conductivity, as shown by the recent work of Samsoen and of Parks and Huffman. An X-ray investigation of the changes in the case of ordinary rosin, shellac and of a synthetic resin having the composition $(C_7H_6)_n$ has now been carried out. The changes in the positions of the diffraction maxima have been followed from 28°–120° C. In the case of shellac and of the synthetic resin, the contraction of the halo is greatest from 28°–45° C.; but in the case of rosin the maximum changes take place at a higher temperature (about 65° C.). The changes in the size, breadth and diffuseness of the haloes as well as the scattering at small angles have been discussed in the light of the Raman-Ramanathan theory. AUTHOR.

662. True Absorption of the Energy of Electromagnetic Radiations in Light Substances. W. V. Mayneord. *Brit. J. of Radiology*, 2. *pp.* 373–389, *Aug.*, 1929.

The various changes of energy which can occur when X-rays enter matter are detailed and discussed with special reference to the Compton effect. From data given by Dauvillier the author calculates that the maximum absorption due to Compton's recoil electrons occurs at 0·05 Å., *i.e.*, in the region of γ-rays which have a wave-length of 0·02 Å. The relative absorption of air and water is discussed, and the effects are found to run a parallel course, the ratio remaining constant. The relative numbers of recoil and photoelectrons is then calculated, but account is not taken of the unmodified scattering coefficient. Recoil electrons are discussed and their absolute ranges in air and water, with respect to their polar distribution. For wave-lengths less than 0·06 Å., 98 % of the energy absorbed is in the form of kinetic energy of recoil electrons, and energy of the photoelectrons is relatively small. Finally, the ranges of photoelectrons and recoil electrons in air are discussed in reference to ionisation and to the minimum size necessary for complete absorption in an ionisation chamber. B. J. L.

663. Temperature and the Compton Effect. G. E. M. Jauncey and H. Bauer. *Phys. Rev.* 34. *pp.* 387–392, *Aug.* 1, 1929.

The intensity of X-rays diffusely scattered by crystals should increase with the temperature according to Debye. It is to be expected that these scattered rays of Debye would be unmodified. Hence the ratio of modified to unmodified rays may decrease with the temperature. Debye's argument applies to powdered crystals and therefore to so-called amorphous substances. The effect of temperature on this ratio has therefore been examined. Using DeFoe's method an aluminium absorbing sheet was transferred from the primary to the scattered beam and the ratio of the two ionisation currents found at temperatures of − 140° C., 25° C. and 565° C. Wave-lengths ranging from 0·32 Å. to 0·62 Å. were scattered by carbon at angles of 60°, 75° and 90°. Also X-rays were scattered from aluminium and copper at angles of 90° and 130°. In each case the difference between the ratios at the different temperatures was not greater than the probable error, implying that there is no effect of temperature on the ratio of modified to unmodified rays in the Compton effect. AUTHORS.

664. Ratio of Intensities of Modified and Unmodified Rays in X-Ray Scattering. E. Albrecht. *Zeits. f. Physik*, 57. 5–6. *pp.* 326–340, 1929.

The filtered out WK_{a1} and K_{a2} lines from a Coolidge tube were allowed to impinge on the scattering substance (Li, C, Al, S, Cu or SiO_2). The scattered radiation consisting of a mixture of the modified and unmodified rays was then passed through a copper absorber, and the absorption coefficient was determined for different thicknesses of the absorber, at each angle of scattering investigated. The variation in absorption coefficient with absorber thickness enabled the proportion of modified to unmodified radiation to be calculated. Scattering angles from 30° to 105° were employed. With increasing scatter angle and decreasing atomic number of the scatterer, the ratio, modified to unmodified intensity, was found to increase. For lithium only modified radiation was present. From the results the formula $\frac{\text{unmodified radiation intensity}}{\text{total scattered intensity}} = k_\phi e^{-\left(\frac{c}{N}\right)^3}$ is deduced, where k_ϕ depends on the scatter angle, and c is a constant. Comparison of the present results which refer to hard rays ($\lambda = 0{\cdot}210$ Å), with other results for softer rays, shows tolerable agreement. W. S. S.

665. Critical Determinations of the K, L_1 and M_1 Levels for Lighter Elements. B. C. Mukherjee and B. B. Ray. *Zeits. f. Physik*, 57. 5–6. *pp.* 345–353, 1929.

It is shown that the true K absorption levels, to which the electron passes at infinity, are determinable from precision measurements of characteristic X-rays and optical lines. Using Sommerfeld's regular doublet separation the values for L_1 and M_1 are also derived. The results are compared with the observed critical potentials obtained by the electron collision method. W. S. S.

666. Secondary Phenomena in X-Ray Spectra. F. K. Richtmyer. *Frank. Inst., J.* 208. *pp.* 325–362, *Sept.*, 1929.

After a lucid summary of the relations between X-ray absorption limits and chemical constitution the double ionisation theorems of Wentzel and Druyvestyn are shown to be insufficient. The $L\alpha$ doublet of silver has seven satellites, with a faint continuous spectrum extending from $L\alpha^{v}$ for "50–60 volts" towards short wave-lengths. Such a spectrum is observed in many other cases. A series of "Moseley graphs" for the satellites of $L\alpha$, $L\beta_1$, $L\beta_2$ and $L\gamma$, for most of the elements from Rb (37) to Sn (50), shows that $\sqrt{\Delta v}$ is practically a linear function of the atomic number. K- and L-satellites are found from Na(11) to Cu(29) and from Cu(29) to Sn(50), *i.e.*, throughout the periods in which the M- and N-shells respectively are being built up. A two-electron jump theory is put forward that the vacancies in an atom, doubly ionised by loss of one electron from an inner and one from an outer shell, are simultaneously filled up by electrons from the next outer shell and from outside respectively. This is shown to be not inconsistent with such evidence as is available.

C. A. S.

667. Ionisation-Spectrometer for X-Rays of Long Wave-Length. H. Kulenkampff and B. Woernle. *Phys. Zeits.* 30. *pp.* 551–554, *Sept.* 1, 1929.

Details are given for making an ionisation spectrometer which can be used for X-rays of long wave-length. It is not suitable for measurements of wave-length, but simply for the measurement of intensity in a region which has been spectroscopically analysed. F. J. W.

668. Dependence of the Magnitude of the Focal Spot at the Antikathode of the Röntgen Tube upon Current Strength. M. A. Rewutzka. *Zeits. f. Physik*, 57. 7–8. *pp.* 556–559, 1929.

The method and apparatus for this determination are fully described. The results show clearly that a change in the surface of the focal spot at the antikathode takes place with increase of current strength, and in the direction anticipated from theoretical considerations. This change, however, is insufficient to explain the deviation obtained by Nasledow and Scharawsky [see Abstract 123 (1928)] from the linear relationship between the intensity of the Röntgen spectral lines and the current strength.

H. H. Ho.

RADIOACTIVITY.

669. Activity of Lead Taken from the Roof of the Paris Observatory. A. Smits and (Miss) C. H. MacGillavry. *K. Akad. Amsterdam, Proc.* 32. 5. *pp.* 610–613, 1929. *In French.*

This work continues the investigation of S. Maracineanu [see Abstract 761 (1926)] on the activity of lead exposed to solar radiation. Experimental details with data are given from which Maracineanu's observations of the emission of α-particles from irradiated lead are confirmed, although whether the phenomenon is due really to solar radiation or to atmospheric dust remains to be established, and further experiments are in progress to settle this question. H. H. Ho.

670. Temperature Coefficient of Radioactive Disintegration. O. K. Rice. *Nat. Acad. Sci., Proc.* 15. *pp.* 593–595, *July*, 1929.

Radioactive transformations have very low-temperature coefficients and cannot be influenced by any variations of temperature within our present command. The author examines the dependence of the changes, with respect to temperature, on the basis of intra-atomic theoretical considerations in regard to uranium and its α-particle emission. There is no appreciable effect from 0–5000° C., or higher. This finding is also applicable to RaC′. B. J. L.

671. Potential Walls and Radioactive Disintegration in Quantum Mechanics. E. H. Kennard. *Phys. Zeits.* 30. *pp.* 495–497, *Aug.* 15, 1929.

The author criticises the statement that on the quantum mechanics a particle of energy W can pass out through a potential wall of height $V > W$, on the grounds that by Heisenberg's principle of uncertainty it can never be asserted definitely that the particle has energy W *and* at the same time lies within the potential enclosure, for energy and position are non-commutative quantities. An argument is developed with a simple example to establish the above. The interpretation of Gamow's theory of radioactive disintegration is discussed from the present viewpoint, and it appears that Gamow's formula follows from known quantum principles without an additional postulate (as assumed by Gamow). W. S. S.

672. Nature of β-Disintegration According to Wave Mechanics. J. Kudar. *Zeits. f. Physik*, 57. 3–4. *pp.* 257–260, 1929.

Gamow has recently given a theory of α-disintegration, and the author bases his investigation of β-disintegration on this. The electron within the radioactive nucleus is supposed to behave as a free particle between walls which to a certain extent are permeable. Certain assumptions are made as to the way in which the wave function of the electron alters inside the nucleus. The mathematical result obtained is in agreement with the rich character of the β-ray spectra. H. N. A.

673. Theory of the Charging Effect on an Insulated Body Exposed to Primary Corpuscular Radiation or to Corpuscular Radiation Initiated by the Cosmic Radiation. W. F. G. Swann. *Frank. Inst., J.* 208. *pp.* 259–274, *Aug.*, 1929.

In order to explain the experimental results already obtained [see next Abstract], as due to the agency of a primary corpuscular radiation from outside the atmosphere, it is necessary to postulate the existence of radiation of a penetrating power twenty-eight times as great as the most penetrating radiation recorded by Millikan and Cameron. Further, an explanation based upon the formation of corpuscular radiation shot into the earth by cosmic radiation also demands the existence of cosmic radiation of far greater penetrating power than any yet observed.

F. J. W.

674. Endeavour to Detect a Corpuscular Current Entering the Earth. W. F. G. Swann and A. Longacre. *Frank. Inst., J.* 208. *pp.* 275–282, *Aug.*, 1929.

The results of the experiment [see Abstract 1488 (1927)] show that the absolute magnitude of the current absorbed by a solid copper cylinder 20·6 cm. in diameter and 19·3 cm. high is not greater than 0·25 % of that which would have been obtained by the complete absorption of a vertical corpuscular current density sufficient to account for the replenishment of the earth's charge. [See also previous Abstract.] F. J. W.

675. Nature of High-Altitude Radiation. W. Bothe and W. Kolhörster. *Zeits. f. Physik,* 56. 11–12. *pp.* 751–777, 1929. *From the Reichsanstalt.*

When two Geiger-Müller counting tubes are placed near to one another it is found that, amongst the deflections produced by high-altitude radiations, there is a noticeable fraction which take place simultaneously in both tubes. From the way in which these simultaneous deflections depend on the relative positions of the two tubes, and from their large number, it is possible to conclude that each pair is due to the passage of a single corpuscle through both counting tubes. The absorption coefficient of this corpuscular radiation has been determined by placing layers of absorbing material between the two tubes, and measuring the diminution of the number of coincidences. The result obtained is that the corpuscular radiation is just as strongly absorbed as the high-altitude radiation itself. The conclusion is that the high-altitude radiation, as far as it has manifested itself in the phenomena so far observed, is of corpuscular nature. Its probable properties are discussed from this point of view. H. N. A.

676. Ozonisation and Interaction of Oxygen with Nitrogen under α-Radiation. S. C. Lind and D. C. Bardwell. *Am. Chem. Soc., J.* 51. *pp.* 2751–2758, *Sept.*, 1929.

Ozonisation in oxygen flowing past an α-ray bulb is higher (per ion pair) the faster the rate of flow and the lower the intensity of ionisation, that is, higher the lower the ozone concentration from either influence, owing to de-ozonisation. The maximum yields of ozone obtained per ion pair (MO_3/NO_2) was not less than 1·5 and may be as high as 2–2·5. De-ozonisation appears to be due to a secondary effect of oxygen ions (or atoms), not to a primary impact with an α-particle. In mixtures of nitrogen and oxygen both ozone and acid-forming oxides of nitrogen are simultaneously formed; also a smaller amount of nitrous oxide. Nitrous oxide formation was investigated only for air. The yield of acid-forming oxides diminishes with decreasing $N_2 : O_2$ ratio, while the total oxidising power toward potassium iodide solution is little influenced. A theory is proposed for this. AUTHORS.

HEAT.

677. Determination of Stefan-Boltzmann Constant of Radiation. C. E. Mendenhall. *Phys. Rev.* 34. *pp.* 502–512, *Aug.* 1, 1929.

A new method of measuring the constant σ is described in which the radiant energy is measured in terms of electrical input. The results of the study of various possible sources of error are discussed quantitatively. The resulting value of σ is $5 \cdot 79 \times 10^{-12}$ watt . cm.$^{-2}$. deg.$^{-4}$. AUTHOR.

678. Radiation Heat Transfer Formulæ. O. A. Saunders. *Phys. Soc., Proc.* 41. *pp.* 569–575, *Aug.* 15, 1929.

The general expression for the radiation heat transfer from a surface is first considered, after which some simple cases are examined, *i.e.*, parallel planes, concentric spheres, etc. Some general conclusions are then drawn for the case of a surface completely surrounded by other surfaces at a uniform temperature, but of no particular simple shape; it is pointed out that whatever the shapes, sizes and relative positions of the various surfaces, the heat transfer per unit area must always lie between minimum and maximum values depending only upon temperatures and emissivities. Lastly, an approximate formula is given for the heat transfer when the surroundings are poor reflectors; this is applied to two non-concentric spheres, one within the other. [See following Abstract.] AUTHOR.

679. Geometrical Radiation Problems. O. A. Saunders. *Phil. Mag.* 8. *pp.* 213–218, *Aug.*, 1929.

The expressions obtained by E. A. Milne [see Abstract 2170 (1929)] on the radiation transmitted by a pair of circular apertures may be deduced as particular cases of the following more general result: If two apertures (not necessarily plane) are such that their bounding lines lie entirely on one and the same sphere, the radiation transmitted per second through both of them is given by $R = IS_1S_2/4\rho^2$, where S_1 and S_2 are the surface areas of the parts of the sphere cut off by the bounding lines of the apertures, and ρ is the radius of the sphere. The properties of such a spherical surface enable a simple expression to be given for the total rate of emission, including all multiple reflections, of radiation from a diffusely reflecting concave surface of uniform curvature. [See preceding Abstract.] E. E. F. d'A.

680. Relationship between Resistance and Heat Exchanges by Flow Through Tubes. L. Schiller and T. Burbach. *Phys. Zeits.* 30. *pp.* 471–472, *Aug.* 1, 1929.

A continuation of previous work by the same authors on the flow of fluids through tubes and the heat transmission consequent upon it. The present paper discusses the subject-matter of the title by an extension of the formulæ previously obtained. S. G. B.

681. Heat Transfer: Liquid Flowing through a Porous Prism. T. E. W. Schumann. *Frank. Inst., J.* 208. *pp.* 405–416, *Sept.*, 1929.

Mathematical formulæ are obtained for the distribution of temperature in a liquid and solid when the liquid, initially at uniform temperature, passes lengthwise through a right porous prism, the sides of which are adiabatic and imprevious to the fluid. It is shown that the temperatures of both liquid and solid are functions of time and of a distance, assuming the well-known laws governing the transfer of heat from a liquid in turbulent motion to a solid. Curves are given showing the temperatures in the solid and in the liquid. If a gas is used, the problem is more complicated, but certain useful results are obtained by a dimensional method. T. B.

682. Realisation of a Black Body at the Melting Point of Palladium by a Tubular Method. G. Ribaud and S. Nikitine. *Comptes Rendus*, 188. *pp.* 618–620, *Feb.* 25, 1929.

A description is given of a tube of palladium, together with dimensions and experimental procedure, which is of small diameter in comparison with its length. It is shown that this tubular method gives an excellent basis or fixed point for pyrometry, the error being extremely small. An anomaly of palladium is discussed in that when the mechanical tension on the tube is greater than 2·5 gm. per sq. mm. the temperature of rupture is suddenly lowered by 8° and then remains constant. The phenomenon is reproducible with great regularity and is explained by an allotropic modification of palladium being formed at 8° below its melting point. Thus are explained the solidification curves of Hoffman, Burgess and Waltenburg. Day and Sosman, in their measurement of the melting point of palladium, also found a modification at 8°, but this difference has never been satisfactorily explained hitherto. S. G. B.

683. Movement of Gases around Electrically-Heated Wires. S. Lenher and G. B. Taylor. *Am. Chem. Soc., J.* 51. *pp.* 2741–2744, *Sept.*, 1929.

A periodic pressure change has been observed in vessels containing an axially placed electrically heated wire. The periodic pressure change has been found to be synchronised with a corresponding fluctuation in the heating current. A mist-free zone around a hot wire in a gas containing a dilute mist has been noted. It has been shown that this zone behaves like the conduction film assumed to exist around a heated body. It has been shown that the diameter of the mist-free zone is dependent on the wire temperature. AUTHORS.

684. Thermostat to Work Off A.C. Mains. J. Hume. *J.O.S.A. and R.S.I.* 19. *pp.* 158–161, *Sept.*, 1929.

Continuous thermal regulation of a 150-litre bath over months, to an accuracy of 0·001° C., is obtained by providing large surfaces to both the regulator, containing 135 c.c. of toluene, and the heater, a nichrome spiral enclosed in glass tubing and consuming 200 watts. The relay possesses a freely mounted armature, and sparking is avoided in both primary and secondary circuits by the use of condensers across the corresponding contacts. The regulator is easily adjustable to the required temperature. L. V. C.

685. Eupatheostat. A. F. Dufton. *Journ. Sci. Instruments*, 6. *pp.* 249–251, *Aug.*, 1929.

The instrument is designed to maintain the temperature of a room at such a level that a black body at 75° F. loses heat at the rate of 17·5 B.T.U./ft.^{2} hour. It is used to investigate the thermal requirements of various rooms and for the comparison of different methods of heating. It consists essentially of a thermostat with electrical heating regulating to 1 % over several months with even a 10 % voltage variation. R. S. R.

686. Design for a Humidity Slide Rule. G. F. Davidson. *Journ. Sci. Instruments*, 6. *pp.* 318–320, *Oct.*, 1929.

A slide rule is described, by means of which the dew-point, the pressure of water vapour, and the relative humidity may be rapidly and accurately obtained from the readings of the ventilated wet- and dry-bulb hygrometer. AUTHOR.

687. Refrigeration. A. R. Stevenson, Jr. *Frank. Inst., J.* 208. *pp.* 143–187, *Aug.*, 1929.

A critical survey of the history, apparatus, methods of refrigeration and cold temperature ventilation. The work is comprehensive and states the present position clearly. S. G. B.

688. New Method of Determining the Temperature of Hot Wires. K. Schlesinger. *Ann. d. Physik*, 2. 8. *pp.* 933–975, *Sept.* 15, 1929.

The temperature is determined from observations on the natural period of the heated wire. The first part of the paper contains a theory of the natural period and its dependence on temperature. Experimentally the natural period was determined by resonance methods, and hence the temperature was deduced. A general accuracy of about 2–5 % is claimed for experiments on the filaments of certain thermionic valves. G. E. B.

689. Melting Points of Normal Paraffins. J. H. Hildebrand and A. Wachter. *Am. Chem. Soc., J.* 51. *pp.* 2487–2488, *Aug.*, 1929.

Determinations of the melting point of dicetyl, synthesised by the method of Sorabji, and carefully purified by several recrystallisations, give a value of 70·2° C., whereas the value given in "International Critical Tables" is 75° C. A search of the original sources shows the values 70, 70·0, 68–70, 69·8, 71, 70, 70·5, 74–75, and 70·5° C., arranged in chronological order. It is, therefore, suggested that the value given in "I.C.T." is too high. The melting points of the normal paraffin hydrocarbons from $C_{19}H_{40}$ to $C_{36}H_{74}$, as deduced from various sources, are found to lie on a smooth curve which is also 3° to 5° C. lower than the values chosen by the expert in "I.C.T." T. B.

690. Investigations on the Critical State. Part IV. Critical State of Ethyl Ether Solutions. E. Schroer. *Zeits. f. phys. Chem.* 142. *Abt. A.* 5. *pp.* 365–390, *Aug.*, 1929.

Continuing earlier work [see Abstracts 2237 and 2238 (1929)], the limiting curves in the temperature-density diagram and the temperature-pressure diagram were determined for a series of solutions of various substances in ether. The materials investigated were triphenylmethane, phenanthrene, benzil and resorcin. The first form of curve consisted of two curves which belong to two definite systems. The second form of curve showed a constant value for dp/dt up to the critical point, and then fell to lower values. The rise of the critical temperature and pressure confirmed the results of Centnerszwer, and was found to be proportional to the number of molecules in solution. The proportionality held up to fairly high concentrations. The retrograde condensation was followed isothermally and quantitatively for some systems. The isotherms of the solutions were strongly displaced towards the liquid end, and most strongly in the region of the greatest compressibility of pure ether. The experimental results were discussed from a theoretical standpoint. F. J. B.

691. Superheating and Intensive Drying of Liquids. S. Lenher. *J. Phys. Chem.* 33. *pp.* 1579–1582, *Oct.*, 1929.

It has been shown that ordinary benzene, carbon tetrachloride, and water can be superheated as much as 30° above the normal boiling point in reproductions of apparatus used in intensive drying work. The conditions favouring superheating of liquids are discussed. Objections are raised to the hypothesis that the degree of association of a liquid is changed on prolonged drying. AUTHOR.

692. Adiabatic Calorimetry. Part I. E. Lange and E. O. Rounsefell. *Zeits. f. phys. Chem.* 142. *Abt. A.* 5. *pp.* 351–364, *Aug.*, 1929.

An exact method of adiabatic calorimetry, involving temperature changes of the order of one degree, was developed. The results of earlier work were examined, and improved methods were introduced. Temperatures were measured with thermometers divided into 0·01° and 0·001°. Precautions were observed to avoid errors due to vaporisation and condensation caused by changes of vapour pressure. The stirring was regulated by an electric regulator, and the heating was controlled by a normal clock and electric regulator. The adiabatic working of the calorimeter was criticised. F. J. B.

693. Calorimetric Methods and the Allotropy of Potassium Nitrate and Chloride as obtained from Heats of Solution. W. A. Roth and C. Eymann. *Zeits. f. phys. Chem.* 143. 5–6. *pp.* 321–353, *Sept.*, 1929.

The first part of the paper is a summary of the values of the heats of solution of KNO_3 and KCl as found in the literature. The differences in the values are considerable, and it is suggested that they are due either to imperfect calorimetric methods or to polymorphic modifications of the salts. The bigger variations are attributed to the first cause. A discussion follows of the three known methods of calorimetry: (1) isothermal; (2) adiabatic; (3) the compensation method. The advantages and disadvantages of different calorimetric vessels are fully discussed, and a clear sketch of the author's calorimetric arrangement is given, with details of construction. The results obtained by the authors show that the variable results found in the literature are almost wholly due to imperfect calorimetric methods. The adiabatic compensation method is found to be the best. The isothermal method also gives reliable results. The value obtained for the heat of solution of $KNO_3.350H_2O$, initial temperature 21° C., was − 8·418 k. cal./mol., and for $KCl.150H_2O$ at 21° C. was − 4·322 k. cal./mol. T. B.

694. Prevention of Heat Losses in Gas Explosions and its Use in the Determination of the Specific Heat of Water Vapour. K. Wohl and G. v. Elbe. *Zeits. f. Elektrochem.* 35. *pp.* 644–648, *Sept.*, 1929. *Paper read before the Deut. Bunsen Gesell., Berlin, May*, 1929.

By means of oxygen-hydrogen explosions at various initial pressures, an attempt has been made to measure the dissociation of hydrogen into atoms more accurately than is possible with chlorine detonating gas [see Abstract 1599 (1924)]. The explosions were carried out with the dried gases containing excess of hydrogen, the initial pressures being 0·5, 1 and 3 atmos. Qualitatively, the results are in accordance with expectations; the higher the initial pressure, the smaller is the dissociation of the hydrogen and the amount of heat consequently used, and the higher the explosion temperature. The difference between the three curves connecting explosion temperature and the excess of hydrogen for the three pressures is, however, much greater than is explainable solely by dissociation of the hydrogen, the loss of heat—dependent on the pressure—being a contributory cause. This loss of heat is, as it should be theoretically, greater at low than at high pressures, and is less in moist than in dry explosions. The addition of water to a gaseous mixture affords, indeed, a means of giving an adiabatic course to explosions which, in themselves, are subject to loss of heat. The results now recorded furnish a confirmation of the specific heats of water vapour calculated from the optical frequencies by means of Einstein functions. T. H. P.

695. Molecular Heats at High Pressures. D. M. Newitt. *Roy. Soc., Proc.* 125. *pp.* 119–134, *Aug.* 1, 1929.

In a previous paper [see Abstract 3331 (1928)] the method of calculating the mean maximum temperature attained during a gaseous explosion in a closed vessel was discussed, and those calculated from experiments for theoretical CO-air and H_2-air explosions at initial pressures of between 5 and 170 atmospheres were given. The data accumulated during these researches have been reviewed and analysed, and extended, with a view to seeing how far it is possible to deduce, not only a quantitative estimate of the energy distribution at the moment of maximum pressure in typical explosions at high pressures, but also the mean heat capacities of the various explosion products over a temperature range from 15° C. up to various definite points between 2600° and 3000° C. The molecular heats of nitrogen, steam and carbon dioxide have been thus studied. A. D.

696. Heat Capacity of Oxygen from 12° K. to its Boiling Point and its Heat of Vaporisation. Entropy from Spectroscopic Data. W. F. Giauque and H. L. Johnston. *Am. Chem. Soc., J.* 51. *pp.* 2300–2321, *Aug.*, 1929.

The method adopted was, with certain improvements (fully detailed), that previously followed by Giauque and Wiebe [see Abstract 1333 (1928)]. The heat capacity was determined from 12·97 to 90·33° K. The melting and two transition points are at 54·39° ± 0·05, 43·76° ± 0·05 and 23·66° ± 0·1 K.; the heats of transition and fusion 106·3 ± 0·3, 177·6 ± 0·5, and 22·42 ± 0·1 cal. per mole respectively. The molal entropy at the boiling point (90·13° K.) of the hypothetical perfect oxygen gas is 40·74 g.cal./1°, as compared with 40·68 deduced from spectroscopic data, and 40·70 from the third law. For $S_{298\cdot 1}$ the spectroscopic method gives 49·03; the third law 49·1. This agreement shows that the magnetons in crystalline oxygen below 23·66° K. do not contribute appreciably to the entropy, and must, therefore, be coupled in a non-random manner into "magneton crystals," the breakdown of which by an applied field explains the large positive susceptibility of solid oxygen on the analogy of the Paschen-Back effect in gaseous ions. C. A. S.

697. Heat Capacity of Toluene from 14° K. to 298° K. Entropy and Free Energy of Formation. K. K. Kelley. *Am. Chem. Soc., J.* 51. *pp.* 2738–2741, *Sept.*, 1929.

Specific heat measurements on toluene covering the temperature range from 14 to 298° K. have been made. The heat of fusion and temperature of fusion were measured. The entropy and free energy of toluene at

298° K. have been calculated. Preliminary values on *m*-xylene are also included. [See also Abstract 2233 (1929).] AUTHOR.

698. Heat of Formation of Sulphur Dioxide. J. R. Eckman and F. D. Rossini. *Bureau of Standards, J. of Research*, 3. *pp*. 597–618, *Oct*., 1929.

The heat of formation of sulphur dioxide has been redetermined. Since the burning of sulphur in excess oxygen results in the formation of varying small amounts of sulphur trioxide, which evolves some 90,000 more joules per mole in its formation than does sulphur dioxide, the difficulties involved in analysing the combustion products for the trioxide and in making the corresponding corrections were obviated by the use of a specially designed calorimetric reaction chamber in which oxygen reacts with an excess of hot sulphur vapour to form pure sulphur dioxide. The heat of formation of sulphur dioxide at 25° C. from rhombic sulphur and gaseous oxygen was found to be $+ 296{,}890 \pm 200$ absolute joules per mole. AUTHORS.

699. Apparatus for Vapour-Tension Determinations by the Transference Method. K. Jellinek and G. A. Rosner. *Zeits. f. phys. Chem.* 143. *Abt. A.* 1. *pp*. 51–54, *Aug*., 1929.

In the transference method a known volume of an indifferent gas is passed at temperature T over the condensed phase of the substance, alloy or fused salt, and the weight of vapour carried away is determined. The apparatus consists of a tube of Pythagoras mass, 60 cm. long, 3·5 cm. internal diameter, heated by a nickel coil embedded in calcined magnesia. The material is placed in several boats in the tube, into which is pushed, through a sleeve, a horizontal quartz tube, reaching into the middle of the furnace tube, for withdrawing the mixture of vapours and nitrogen. The nitrogen is introduced at the boat level at the other end of the furnace, and the discharge tube, which widens out into a condenser outside the furnace, is at a higher level. The discharge tube and condenser, which are ground into the outer fittings, can easily be exchanged for a series of experiments at different temperatures, determined by a thermocouple near the inner end of the discharge tube. H. B.

700. Vapour Tensions of PbI_2, CuI, Cu_2Br_2, AgI and AgBr by the Transference Method. K. Jellinek and A. Rudat. *Zeits. f. phys. Chem.* 143. *Abt. A.* 1. *pp*. 55–61, *Aug*., 1929.

With the apparatus described [see preceding Abstract], the authors determine the vapour tension of PbI_2 at temperatures between 650° and 800°, of CuI between 900° and 1100°, Cu_2Br_2 between 900° and 1100°, AgI between 900° and 1200°, and AgBr between 1000° and 1200°, and calculate their molecular heats of evaporation. Observations are made at three or four different temperatures and different rates of gas-vapour flow. The molecular weights are found as stated above, thus CuI (not Cu_2I_2), but Cu_2Br_2, and the method is reliable. H. B.

701. Heterogeneous Gas Equilibrium with Notable Vapour Pressures of Suspended Bodies. K. Jellinek. *Zeits. f. phys. Chem.* 143. *Abt. A.* 1. *pp*. 69–78, *Aug*., 1929.

The paper discusses thermodynamically the equation of the reaction isochore for heterogeneous gas equilibrium with perceptible floating or suspended dust particles. A direct calorimetric method of measurement of the heat involved is also suggested. S. G. B.

702. Structure of Nuclei for Condensation of Water Vapour in Non-Ionised Dust-Free Air. E. X. Anderson and J. A. Froemke. *Zeits. f. phys. Chem.* 142. *Abt. A.* 5. *pp.* 321–350, *Aug.*, 1929.

A comprehensive survey of the subject is given, including also a discussion of the phenomena accompanying precipitation of the vapour. The work of previous investigators is set out in tabular form, together with full details of their numerical results. A new apparatus is described for the measurement of the expansion accompanying the condensation. This is based on the Wilson principle and is fully described in detail. The expansion of water in a non-ionised dust-free air medium is newly estimated. As the result of 50 determinations the mean value of 1·2006 ± 0·0007 is given, which is in fair agreement with and replaces the value given by Wilson, namely, 1·252. S. G. B.

703. The Homogeneity of Water. K. F. Bonhoeffer and P. Harteck. *Zeits. f. phys. Chem.* 5. *Abt. B.* 3–4. *pp.* 293–297, *Sept.*, 1929.

The authors first establish that in consequence of the different energy content of a gas in the para- and ortho- systems a different vapour pressure is to be expected. In the case of water, however, this effect has not been determined in spite of very great accuracy of measurement. [See also Abstract 251 (1930).] H. H. Ho.

704. General Method of Measuring the Partial Pressure of Mercury at Room-Temperatures. L. L. Hirst and A. R. Olson. *Am. Chem. Soc., J.* 51. *pp.* 2398–2403, *Aug.*, 1929.

A method and apparatus for the determination of the vapour pressure of mercury are described, dependent upon the fact that if mercury resonance radiation falls upon a mixture of hydrogen, ethylene and mercury vapour, a reaction occurs which results in a decrease of pressure. Vapour pressures are calculated from the observed rates of reaction by means of Randall and Langford's equation for the free energy of mercury. The following values of the vapour pressure of mercury (10^{-5} cm. of mercury) were found at the temperatures given (° C.): 88°, 0; 273·1°, 1·98; 277·9°, 3·20; 282·8°, 4·92; 287·0°, 7·36; 291·1°, 10·72; 299·1°, 20·1. The following values (measured in the above units) of the vapour pressure of mercury over thallium amalgams of the respective molar concentrations stated were determined at 26° C.: 1·000, 20·1; 0·835, 15·15; 0·644, 9·6; 0·316, 6·9. The activities calculated from these results agree well with those calculated from the e.m.f. measurements of Richards and Daniels. The broadening of the absorption line of mercury by hydrogen for its own resonance light and the change in the atomic absorption coefficient of mercury in the presence of hydrogen are briefly discussed. [See also Abstract 339 (1928).] J. S. G. T.

705. Vapour Pressure of Halogen Salts of Thallium and Lead. F. Volmer. *Phys. Zeits.* 30. *pp.* 590–596, *Sept.* 15, 1929.

The vapour pressures of thallium chloride, bromide and iodide, and of lead chloride and bromide were determined by a streaming method. The halogen salt was heated in a glass or quartz U-tube and air or nitrogen passed over the salt. The loss of weight of the salt in the U-tube was determined. The measurements were made over a considerable range of temperature. The vapour pressures were calculated by the formulæ of Ostwald and Pfaundler. The reliability of the method was tested by determining the vapour pressure of mercuric bromide. The results were in agreement with the determinations of Arctowski, Stelzner and Niederschultze. F. J. B.

706. Molecular Orientation and Partial Vapour Pressures of Binary Mixtures. Part I. Systems Composed of Normal Liquids. Part II. Systems Containing an Alcohol. C. P. Smyth and E. W. Engel. *Am. Chem. Soc., J.* 51. *pp.* 2646–2670, *Sept.*, 1929.

Part I. An apparatus is described for the measurement of the partial pressures of binary liquid mixtures by a dynamic method. Results are given for the vapour pressures of eight different combinations of supposedly normal liquids and of several of the pure components. These data are used in the examination of Langmuir's theory of molecular surface energies, which is found to have approximate applicability. Deviations from the theoretical behaviour are ascribed to the presence of electric doublets in the molecules. Part II. Measurements of the partial vapour pressures of six binary liquid systems containing an alcohol as one component give results deviating considerably from those required by Langmuir's theory. The divergences are explained in terms of the interaction of the electric doublets contained in the molecules. It is concluded that, as this interaction is dependent not only on the electric moments of the doublets, but also on their locations in the molecules and on the sizes and shapes of these molecules and probably on the constraints upon the electrons in them, no generally valid quantitative formulation of the effect is yet possible. T. H. P.

707. Partial Pressures of Binary Solutions. R. W. Dornte. *J. Phys. Chem.* 33. *pp.* 1309–1331, *Sept.*, 1929.

The equation $a \log \frac{G_1}{G_2} - \log \frac{P_2 - P_2}{P_2'} = \log K$, in which G_1 and G_2 are the numbers of grammes of the respective components in the liquid phase, P_2 the vapour pressure of the pure solvent, P_2' its partial pressure in the solution, and *a* and K empirical constants, is found to apply to binary systems of one volatile component over a very large range of concentrations for all combinations of normal and associated liquids. The equation represents the system benzene-carbon bisulphide remarkably well at three different temperatures, and the same is the case for the data for the system ethyl alcohol-water at 25° C. over a wide range of concentrations. The results obtained by the interferometer method of determining partial pressures are unreliable unless an entirely empirical calibration is used. T. H. P.

708. Determination of Heat of Evaporation of Liquid Mixtures. V. Kirejew. *Zeits. f. Physik*, 57. 5–6. *pp.* 403–410, 1929.

The heat of evaporation of liquid mixtures can be determined by two indirect methods, (1) from the heat of evaporation of the pure components and the heat of mixing, (2) from the vapour pressure of mixtures. The results of previous investigators have been given in contradictory form, and the only attempt at comparison of the two methods, that made by Masing (*Zeits. f. phys. Chem.* 81. p. 223, 1913) led to incompatibility of results. The author has compared the results of calculation from both methods with direct experimental results. The magnitude of the heats of evaporation of single components obtained from mixtures may be very different from the heats of evaporation in the pure state. The investigation is limited to binary mixtures, data being given for benzol-chloroform and acetone-chloroform mixtures. Lewis' method of partial molar magnitudes is employed. The results obtained disprove not only the results of Masing on the incompatibility of both indirect methods, but confirm the admissibility of both methods from a comparison of results with experimental data. T. B.

709. Sama Condition. E. A. Holm. *Comptes Rendus*, 189. *pp.* 483–484, *Sept.* 30, 1929. *Arkiv. f. Mat., Astron., och Fysik, Stockholm,* 21A. 12. *pp.* 1–72, 1929.

Experiments carried out by the author in 1925 on the vapour of solid crystalline diacetone-xylose ($C_{11}H_{18}O_5$) are described, and it is stated that the values of $D_D - D_L$ were the same (within the limits of experimental error) on each occasion. Results are given, but it is noted that it is not possible to evaluate the gradient of the temperature-rise which characterises the Sama condition of this particular vapour as the specific heat is unknown. Corrections applied to the various observations and the precautions taken to avoid errors are given, and the author claims that the results form a new proof in support of the theory of the existence of $D_D - D_L$. [See also Abstracts 1944 (1928) and 550 (1929).] J. G. H. B.

710. Equation of State. R. Majumdar. *Calcutta Math. Soc., Bull.* 21. *pp.* 107–114, *June*, 1929.

Van der Waals' equation of state can be written as an infinite series, $p + a/V^2 = (RT/V)[1 + \phi_1(b/V) + \phi_2(b/V)^2 + \phi_3(b/V)^3 + \ldots]$, where ϕ_1, ϕ_2, ϕ_3 are numerical coefficients. The value of ϕ_1 has been shown by van der Waals and others to be unity, and Jäger, Boltzmann and others have obtained the value of ϕ_2 as 5/8. The calculation of ϕ_3 is rather more difficult, as the overlapped volume of the "Deckungssphären" has to be considered when there are collisions of 3 molecules at a time. Van Laar, corrected by Boltzmann, obtained the value $\phi_3 = 0{\cdot}2869$, and H. Happel found $\phi_3 = 0{\cdot}288$. The present writer employs the Gibbs law of canonical distribution $\left(\rho = Ne^{\frac{\psi - U}{\Theta}}\right)$ to obtain the equation of state to any degree of approximation. His value for ϕ_3 is $0{\cdot}28689$, in good agreement with the value ($0{\cdot}2869$) obtained by Boltzmann. A special case is also discussed. T. B.

711. Equation of State of a Mixture Determined from the Equations of State of its Constituents. W. E. Deming and Lola E. Shupe. *Frank. Inst., J.* 208. *pp.* 389–395, *Sept.*, 1929.

In a recent paper [see Abstract 554 (1929)] Kleeman gave a method by which the equation of state of a mixture may be derived from those of its constituents. Kleeman's scheme can be described as "combination of coefficients." The author develops another method, which is to derive the parameters for the equation of state of the mixture from the parameters for the pure components, *e.g.*, by linear combination. This idea has recently been used by Beattie on mixtures of nitrogen and methane, using the Beattie-Bridgeman equation of state. Tables are given of the observed pressures (in mixtures of nitrogen and methane) with those calculated by (*a*) linear combination of the parameters, (*b*) combination of the coefficients. In general, method (*a*) gives the best results, and it is observed that method (*b*) has less rational theoretical basis, is usually more laborious to use, and reproduces the data on mixtures of methane and nitrogen less accurately than the combination of parameters. T. B.

712. Joule-Thomson Effect and Heat Capacity at Constant Pressure for Air. O. C. Bridgeman. *Phys. Rev.* 34. *pp.* 527–533, *Aug.* 1, 1929.

The constants for air in the equation of state of Beattie and Bridgeman are evaluated from the p-v-T data of Holborn and Schultze, and this numerical equation is used to compute μC_p at various temperatures and densities. From the C_p data at one atmosphere of the Reichsanstalt for air, corresponding values of C_p at the same temperatures and densities are calculated by means of the equation of state. The values of μ obtained from these two sets of calculations are plotted along isotherms against the corresponding pressures and the values at even pressures and various temperatures are in good agreement with the experimental data of Roebuck. The computed C_p data are compared with those of Roebuck and of Holborn and Jakob and are in good agreement with the values obtained by these experimenters. The Joule-Thomson inversion curve obtained from the equation of state is in good agreement with the experimental values given by Roebuck. AUTHOR.

713. Re-Determination of the Limiting Value of the Expansion and Tension Coefficients of Helium, Hydrogen and Nitrogen. W. Heuse and J. Otto. *Ann. d. Physik,* 2. 8. *pp.* 1012–1030, *Sept.* 15, 1929. *From the Reichsanstalt.*

A new method was employed in which pressures were fixed by means of plantinum points melted into the manometer tube at different heights, and volumes obtained by weighing the amount of mercury contained in them. The isotherms of He, H_2, Ne, Ar, N_2 and O_2 in the region about 0·4 m.–1 m. are straight lines, and their inclinations agree with those determined by measurements at higher pressures. The limiting value calculated for the pressure $p = 0$, using known thermodynamic relations, in the cases of He, H_2 and N_2 is $\gamma = 0{\cdot}0036609$, T_0 being 273·16. The method of linear extrapolation to $p = 0$ gives $\gamma = 0{\cdot}0036610$. Considering previous Reichsanstalt results, which give a mean value of $\gamma = 0{\cdot}0036607$, the general mean $\gamma = 0{\cdot}0036608$ is obtained, with $T_0 = 273{\cdot}16$. H. N. A.

714. Wave Function and Distribution of Velocity for a Degraded Gas. W. Lenz. *Zeits. f. Physik,* 56. 11–12. *pp.* 778–789, 1929.

Heitler has made a first rough estimate of the effect of the finite magnitude of the molecules by idealising the gas as a cubical lattice consisting, except for one molecule, of molecules which are fixed in position; and was able in this way to obtain the order of magnitude of the energy of the lowest characteristic vibration. The author assumes that all the molecules except one are fixed in position, but that these positions are irregularly distributed in space. The gas is assumed to be rare, so that the molecular dimension is small compared with the intermolecular distances; and expressions are obtained for the characteristic functions and the spectrum of the characteristic values of the gas. The result shows a departure from the Maxwell velocity distribution, at temperatures which are so far removed from the absolute zero that it seems possible that experimental verification may be obtained. H. N. A.

715. There is No Second Principle. C. Raveau. *Comptes Rendus,* 188. *pp.* 1662–1665, *June* 24, 1929.

Thermodynamics deals with transformations, reversible and irreversible, and demonstrates certain equalities and a condition of signs. The equalities, which lead to closed reversible cycles, are the consequence solely of the notion of reversibility, and not of a principle depending on an equality. Clausius confounded two distinct ideas in the theorem (of Carnot) and the principle (of Clapeyron), and attempted to demonstrate the first by making it a consequence of the second [see Abstract 1929 (1929)]. The author concludes that in the accepted sense of the term there is no second principle. T. B.

716. Proof of the Maxwell–Clausius Relation Without Using Carnot's Principle. V. Karpen. *Comptes Rendus,* 189. *pp.* 359–360, *Aug.* 26, 1929.

Replies to a paper by Verschaffelt, who has criticised the author's proof of the Maxwell–Clausius relation. Verschaffelt thinks that the author's proof is based on a hypothesis which has been implicitly introduced, and which in general cannot be verified. It is pointed out that the hypothesis in question is in reality the principle of equivalence, which was explicitly mentioned. Explains the meaning of the magnitude k used in the former paper, which was not understood by Verschaffelt. H. N. A.

717. Proof of the Ergoden Principle and the H Theorem in the New Mechanics. J. v. Neumann. *Zeits. f. Physik,* 57. 1. 2. *pp.* 30–70, 1929.

A highly mathematical paper whose object is to furnish an explanation of the relations between the macroscopic and microscopic methods of regarding complicated systems. The most important conceptions of statistical mechanics are given interpretations in terms of quantum mechanics, and the Ergoden principle and the H theorem are formulated and proved. G. E. A.

718. Theoretical Evaluation of Entropies of Aqueous Ions. W. M. Latimer and C. Kasper. *Am. Chem. Soc., J.* 51. *pp.* 2293–2299, *Aug.*, 1929.

Latimer and Buffington [see Abstract 738 (1927)] suggested that the entropy change ΔS of the process: ion (gas) = ion (aq.) is represented by $\Delta s = f(e^2/r)$, where e is the ionic charge and r the radius of the ion cavity in the water solution. The nature of this function is discussed. ΔS consists of two parts: ΔS_1, due to the polarisability of the medium, shown to be negligible; and ΔS_2, due to the electrostatic compression of the water molecules. ΔS_2 for large positive ions is calculated, on certain assumptions, by means of the relation $dS = -(dV/dT)_p dP$ (i), and the equation deduced from Zwicky's results [see Abstract 324 (1926)], $P = (3 + 2D)(D - 1)e^2/4O\pi D^2r^4$ (ii), where D is the dielectric constant of water, to be $-22e^2/r$ cal./deg./mole (iii). r is then deduced from Born's expression $\Delta F = -e^2(D - 1)/2rD$ (iv); whence $\Delta S = 1{\cdot}35\Delta F \times 10^{-4}$ cal./deg. (v), which gives values for ΔS for sodium, potassium, rubidium, silver, thallium and barium agreeing satisfactorily with experimental results. Equation (iii) applied to small ions indicates that at very high pressures the coefficient of expansion of water probably diminishes rapidly. Lastly, entropy values for chlorine, bromine and iodine ions deduced from crystal lattice energies agree approximately with experimental values. C. A. S.

SOUND.

719. Vibrations Along the Optic Axis of a Quartz Oscillator. E. P. Tawil. *Comptes Rendus*, 189. *pp*. 163–164, *July* 22, 1929.

By observation in polarised light of many quartz piezoelectric oscillators of different shapes it is found that, contrary to the Curie laws, vibrations do occur along the optic axis. W. H. GE.

720. Forced Vibrations of Discs. G. Franke. *Ann. d. Physik*, 2. 6. *pp*. 649–675, *Aug*. 26, 1929.

The vibrations of peripherically stretched discs calculated from the differential equations. Experimental verifications. Forty-eight illustrations of nodal lines. A. D.

721. Interferometer for Sound Waves. G. D. West. *Journ. Sci. Instruments*, 6. *pp*. 254–256, *Aug*., 1929.

A source of sound is placed within a cylindrical tube closed at one end. Two sets of waves issued from the open end—one directly, and one by reflection from the closed end. The two sets can be superposed so as to reinforce or to interfere destructively with each other, and thus to produce maximum sound or silence. The movements of the source necessary to effect these changes enable a determination of the wave-length to be made. AUTHOR.

722. Measurement of Total Energy of Sound Sources. E. Meyer and P. Just. *Zeits. f. techn. Physik*, 10. 8. *pp*. 309–316, 1929. *From the Telegraphentechn. Reichsamt.*

Describes an experimental method for measuring the total amount of energy radiated by a sound source in a completely enclosed room having low absorption. A special method is used to determine the absorption of the room, and a calibrated electrostatic microphone is used to measure the energy density of sound set up in the room. These two measurements with the aid of the Jäger theory enable a determination to be made of the total sound energy of the source. The validity of the method is established by comparison with previous methods. Measurements are given upon frequency response and efficiency of loud-speakers and upon the energy of speech and of various musical instruments. W. H. GE.

723. Absolute Measurement of Sound Intensity. F. D. Smith. *Phys. Soc., Proc*. 41. *pp*. 487–495; *Disc*., 496–499, *Aug*. 15, 1929.

An absolute measurement of sound pressure is described in which the sound is received with a moving-coil receiver. The signal heard after amplification is compared with the signal produced by a small-known electromotive force v applied to the receiver. It is shown that when the two signals are equal in intensity the following simple relation connects the total sound pressure P on the receiver with the electromotive force v, $P = vHl/z_m$, where H is the strength of the magnetic field in which the moving coil, consisting of a length l of wire, moves, and z_m is the motional impedance of the receiver at the frequency of the sound. It is shown that the phase also of the sound can be determined with the aid of a phase-shifting transformer. Since the measurement is independent of the amplifying circuit, it is possible to use a high degree of amplification and very feeble sounds may therefore be measured. AUTHOR.

724. Mechanical Method of Measuring Sound Pressure. B. E. Eisenhour and F. G. Tyzzer. *Frank. Inst., J.* 208. *pp.* 397–404, *Sept.*, 1929.

A sound meter is described by which the pressure in sound waves of various frequencies and intensities can be measured by the aid of a special mechanical rectifying valve. The instrument contains a number of diaphragm units, each unit consisting of two circular discs sealed at their circumference, and centrally attached to adjacent units by a conducting passage. The assembled units are supported at the centre of one side so that the opposite side of the assembly can move freely in a vertical direction in response to a change of pressure. The valve is situated at the closed end of an adjustable cylindrical resonator, and communicates with the interior of the units the motion of which is transmitted to a double-lead screw supported in a fixed nut. A pointer on the top end of the nut moves over a circular scale calibrated in dynes per sq. cm. The instrument can function from less than one up to several thousand dynes per sq. cm., and can be used for absorption measurements, efficiency of sound-generating devices and other purposes. G. E. A.

725. Sound Propagation in Gas Mixtures. D. G. Bourgin. *Phys. Rev.* 34. *pp.* 521–526, *Aug.* 1, 1929.

An earlier treatment [see Abstract 3111 (1929)] of the propagation of sound in mixtures of two gases is generalised and simplified somewhat. The essential point of the theory is the consideration of the internal energy variations by the assignment of fictitious internal state temperatures which, in the simplest case assumed here, are taken to be constant for each of the component gases. The long wave-length velocity expression is directly interpretable as a Laplace formula for a gas of mean reciprocal mass and averaged specific heat. From a more general point of view the velocity of propagation of infinitesimal waves is always given by the Laplace result provided a frequency variation of specific heats be recognised. Explicit mention is made of the detailed effect of viscosity and the two conductivities. Experimental data support theory. AUTHOR.

726. Theory of Acoustic Wave Filters. R. B. Lindsay. *Phys. Rev.* 34. *pp.* 652–655, *Aug.* 15, 1929.

Comparison is made of the lumped impedance theory of Stewart and the more recent transmission theory of Mason [see Abstract 2579 (1927)]. It is found that for the low-frequency pass and single-band types the former theory gives to a very close approximation the same frequency limits for the transmission region as the latter. The weak point of the former is the high-frequency pass type, where Stewart's formulæ are semi-empirical. The connection between these and the corresponding formulæ of Mason is investigated. AUTHOR.

727. Connectors in Acoustical Conduits. R. B. Lindsay. *Phys. Rev.* 34. *pp.* 808–816, *Sept.* 1, 1929.

Employing the horn theory of Webster, the power transmission through an acoustical connector joining two conduits is calculated when the law of the change of area of the connector is of the form $S = S_0\phi(x)$. The general result is applied to the following special cases: (1) Conical connector, $S = S_0 x^2$, for which it is found that the transmission approaches unity with increasing kl, where l is the length of the connector and $k = 2\pi/\lambda$; curves are given showing the exact dependence of the transmission on frequency for various values of l and the expansion ratio m. (2) Bessel connectors of higher order, $S = S_0 x^a$ where a can take all values, in which case it is found that the transmission for kl large approaches a value approximately independent of a. (3) Exponential connector, $S = S_0 e^{ax}$, the limiting case of the Bessel connectors, with a transmission ratio showing little difference from that of the former. (4) The connector whose generating curve has a point of inflection, $S = S_0 e^{-ax^2}$, for which for large kl, the transmission differs little from that of the previously discussed connectors. The phase change introduced by the connector is calculated for the special cases mentioned and is shown to approximate kl in the limit of increasing kl. AUTHOR.

728. Acoustical Control of Theatre Design. H. L. Cooke. *Frank. Inst., J.* 208. *pp.* 319–324, *Sept.*, 1929.

In the present design of an auditorium or theatre the desired distribution of sound is first decided, and the form of the hall is then worked out step by step. In practice this method is found to lead to a form of hall well in agreement with the trend of modern design, and there appears to be no conflict between the best acoustical design and architectural considerations. Generally, the plan of the hall and stage is decided on, and the form and position of the audience surface fixed. The hall is imagined as built, with walls in position, but no roof. The roof is then designed to reflect the sound in such a way that at no point would the total received intensity fall below some calculated minimum. The form of ceiling arrived at does not closely resemble any simple geometrical form. The longitudinal vertical median section shows increasing curvature towards the back of the hall, and the transverse vertical sections show the opposite effect. This method of design ensures that all seated beyond about two-fifths of the whole length will hear with equal clearness.

G. E. A.

729. Reception and Analysis of Ship Noises. E. Lübcke. *Zeits. f. techn. Physik*, 10. 9. *pp.* 378–382, 1929.

Description of two instruments for the reception, with true intonation, of subaqueous noises which proceed, *e.g.*, from a ship's propeller. One is based on Riegger's condenser-microphone circuit, the other on the carbon microphone with tightly packed particles. Records taken by oscillograph and subjected to harmonic analysis led to the production of a sound spectrum indicating the approximate variation of amplitude with frequency for a chosen series of frequencies. The results appear to show that each motor-boat or steamer has a characteristic sound spectrum, and that change of the screw speed strengthens certain frequency components in the spectrum. G. E. A.

ELECTRICITY AND MAGNETISM.

ELECTROSTATICS, TERRESTRIAL ELECTRICITY AND MAGNETISM.

730. Interferometric Observations on Liquids in an Electric Field. K. Schaum and E. Walter. *Zeits. f. wiss. Phot.* 27. *pp.* 109–112, *Sept.*, 1929.

Experiments were made with nitrobenzene, *o*-nitrotoluene, *ter*-amyl chloride and ethyl phenylacetate. These were examined in an interferometer when under the influence of a lateral electric field. Temperature-effects were determined by observations after short-circuiting the field, and a residual effect was observed which was opposite to that which would be produced by electrostriction. T. M. L.

731. Dielectric Polarisation of Solutions of Egg Albumen. (Miss) Y. Garreau and N. Marinesco. *Comptes Rendus,* 189. *pp.* 331–333, *Aug.* 21, 1929.

Describes the method of preparing crystalline egg albumen (*ovalbumine*). The dielectric constant has been measured with high frequencies, wave-length 6·5 metres, temperature 20° C. A diagram shows the variation of specific inductive capacity with *p*H. This shows the superposition of two contrary phenomena, the first of which would give a minimum at the isoelectric point, and the second, due to the affinity of the albumen molecules for water, a maximum at the isoelectric point. H. N. A.

732. Dielectric Constant of Ethyl Ether in the Critical State. N. Litvinoff and W. Litvinoff. *Zeits. f. Physik,* 57. 1–2. *pp.* 134–144, 1929.

The method based upon that of Dowling is briefly described. The results obtained near the critical state do not support the theories advanced by Gaus and Debye. A. A. D.

733. Dielectric Constants of Argon and Neon. A. B. Bryan. *Phys. Rev.* 34. *pp.* 615–617, *Aug.* 15, 1929.

The heterodyne beat method has been used to measure at room-temperatures the dielectric constants of argon and neon relative to air. The value for air is assumed to be 1·000589 and the values found for argon and neon are 1·000574 and 1·000148 respectively, for normal temperature and pressure. Simultaneous refractive index measurements agree with previous determinations and indicate that the gases contain no appreciable impurities. An oscillator employing a shield grid tube is described for which the frequency is very little affected by changes in the various battery voltages. [See also Abstract 281 (1929).] AUTHOR.

734. Dielectric Constants and Electric Moments of Alcohol Vapours. J. B. Miles, Jr. *Phys. Rev.* 34. *pp.* 964–971, *Sept.* 15, 1929.

The dielectric constant and electric moment of methyl, ethyl, *n*-propyl, *n*-butyl alcohol vapours are given. Measurements of the dielectric constant of these alcohol vapours were made at several temperatures. A new method was used for measuring the pressure of the hot vapour. The agreement with Debye's equation for the dielectric constant of gases is good at higher temperatures where there is no association. Association is discussed. The moments are calculated and the following results obtained: methyl alcohol, $A = 1\cdot09 \times 10^{-3}$, $\mu = 1\cdot68_0 \times 10^{-18}$; ethyl alcohol, $A = 1\cdot58 \times 10^{-3}$, $\mu = 1\cdot69_6 \times 10^{-18}$; *n*-propyl alcohol, $A = 2\cdot30 \times 10^{-3}$, $\mu = 1\cdot65_7 \times 10^{-18}$; *n*-butyl alcohol, $A = 2\cdot91 \times 10^{-3}$, $\mu = 1\cdot65_9 \times 10^{-18}$.

AUTHOR.

735. Some Applications of Electric Moments to Electronic Theories of Valence. C. P. Smyth. *Am. Chem. Soc., J.* 51. *pp.* 2380–2388, *Aug.*, 1929.

In this investigation electric moments are used as a test of those electronic theories of valence which require polarity in the molecule. The absence of electric moment in methane, ethane and the higher paraffins shows that there is no measurable alternating polarity in the hydrocarbon chain or inherent dissymmetry in the electron linkages of alkyl radicals. The absence of variation in the moments of the higher ketones and alkyl halides leads to the same conclusion, and shows that in these carbon chains no measurable polarity is transmitted through more than two atoms. The ethylene double bond has no measurable polarity, but when different radicals are attached on opposite sides of the bond polarity may occur. The absence of rotation about the double bond is evidenced by the difference in moment between the *cis* and the *trans* isomers of the acetylene dihalides. It is suggested that the directive influences and effects upon chemical activity commonly attributed to differences in polarity may be due rather to differences in the energy levels occupied by the valence electrons, which may or may not give rise to measurable polarity.

H. H. Ho.

736. Electric Moments of Aromatic Paradiamines. A. Weissberger and R. Sängewald. *Zeits. f. phys. Chem.* 5. *Abt. B.* 3–4. *pp.* 237–240, *Sept.*, 1929.

Since Williams and Weissberger's measurements of the dielectric constants of *p*-phenylene diamine and benzidine [see Abstract 2945 (1929)] were carried out in benzene solutions in which the products were only very sparingly soluble, the present authors have measured the much more concentrated benzene solutions of N-tetramethyl-*p*-phenylene diamine and N-tetramethyl-benzidine, and found both products to possess the same dipole moments. The conclusion is drawn that the previous value of $0\cdot3 \times 10^{-18}$ for the moment of *p*-phenylene diamine is incorrect, and that the argument for a folded (Kaufler) formula for benzidine is untenable.

H. H. Ho.

737. Temperature Dependence of Dipole Moment. O. Werner. *Zeits. f. phys. Chem.* 4. *Abt. B.* 5. *pp.* 393–400, *Aug.*, 1929.

Reference is made to Höjendahl's distinction between rigid and movable dipoles, the latter only giving average values for moments, since an equilibrium of several possible forms is concerned. It is assumed that a change of temperature brings about a change of the equilibrium. Dipole measurements are described for benzonitrile as an example of a rigid dipole, and for hydroquinone diethyl ether as a movable dipole. Measurements carried out at three temperatures (20°, 40° and 60°) show constancy of moment for benzonitrile, but a 16 % increase for hydroquinone diethyl ether; the latter indicating a displacement of equilibrium between the different dipoles with temperature. The importance of this result for the pentaerythrite problem is pointed out. [See also Abstract 274 (1930).] H. H. Ho.

738. Dipole Moments of Hydrogen Cyanide and Certain Nitriles. O. Werner. *Zeits. f. phys. Chem.* 4. *Abt. B.* 5. *pp.* 371–392, *Aug.*, 1929.

An improved resonance method is now described for the determination of dielectric constants to an accuracy of about 1 % which is characterised by the employment of a piezoelectric quartz crystal as frequency stabiliser. The results of the measurements of the electric moments of hydrogen cyanide, acetonitrile, propionitrile, butyronitrile and benzonitrile are given. The dielectric constant and density of solid prussic acid are determined anew. A comparative consideration of the results of these measurements shows that with the nitriles (as also in the case of the other aliphatic halogen compounds) the dipole extends more over the whole molecule in contrast to the alcohols and amines where the dipole is localised in the — OH and — NH_2 group respectively. The consequence is that with nitriles there is a definite connection between polarisation and molecular volume, which is not the case with the alcohols. A limiting value for the moment is attained among the nitriles at $C_8H_{13}CN$. The parallelism between the optical and electrical behaviour of the CN and OH groups is discussed and the probability indicated of the nitrile union in hydrogen cyanide. H. H. Ho.

739. Characteristic Regularity of Molecular Polarisation of Certain Pure Dipole Substances. P. Gross. *Phys. Zeits.* 30. *pp.* 504–506, *Aug.* 15, 1929.

Within pure polar liquids forces occur which are produced by molecular interaction and entail the failure of the Clausius-Mosotti law. In the present investigation a large number of organic halogen compounds have been studied, from which it is established that the calculated molecular polarisation is smaller than the total polarisation of the free molecule, indicating that by the mutual interaction of the polar molecules their apparent moment and total polarisation is reduced. H. H. Ho.

740. Appearance of Ions on Decomposition of Ozone and Ionisation of the Stratosphere. H. Hellmann. *Ann. d. Physik,* 2. 6. *pp.* 707–732, *Aug.* 26, 1929.

In connection with geophysical questions, especially the problem of the explanation of the nocturnal ionisation of the upper atmosphere, the question of the appearance of ions on the decomposition of ozone was experimentally investigated. In opposition to an earlier investigation of Gunckel and measurements by Brewer, no ionisation was observed. The accuracy of measurement could be raised so far that detection must occur if a pair of ions were liberated from each 5×10^{15}th decomposing molecule. Brewer found an effect proportional to the tension up to about 2000 volts. Some measurements with high tension showed a similar effect, which was explained as a disturbance through a change of capacity of the measuring condenser due to a change of temperature occurring with the reaction. From these observations it would appear that the various hypotheses that the electric conductivity of high atmospheric layers depends on the presence of ozone lose their foundation. J. J. S.

741. Atmospheric-Electric Researches Made in 1928 during the Nobile Arctic Expedition. F. Běhounek. *Terr. Mag.* 34. *pp.* 173–198, *Sept.*, 1929.

742. Origin of Heat Thunderstorms and their Prediction by Means of Atmospherics. J. Lugeon. *Comptes Rendus*, 189. *pp*. 363–365, *Aug*. 26, 1929.

The observations have been made in the neighbourhood of Zurich, and the author has found on thirty summer days, with no wind up to an altitude of 8000 m., a distinct kink on the usual lowering of the curve of atmospherics just before sunrise. This kink does not occur on days when cumulus clouds exist and strong convection, but no storms; it appears to indicate the existence of a thick layer of stratified and electrified air between the altitudes 4500 m. and 6000 m.; there is probably an inversion of temperature. When the cumulus is rising during the morning the parasites consist of infrequent clicks of small intensity; but suddenly, between 11 a.m. and 2 p.m., the frequency jumps up from 10 to 100 discharges, and at the same moment the head of the cumulus is covered with a veil of false cirrus, which spreads over the whole sky. The parasites then become oscillating, and very intense (grinders), and lightning and rain follow in one or two hours. The frequency of the atmospherics drops suddenly at the conclusion of the thunderstorm. The false cirrus appears to be formed when the top of the cumulus reaches the electrified layer mentioned above. The author traces the development of the electric action according to Simpson's theory, and points out that only a short warning is given by the atmospherics, though some information may be given by the jump before sunrise. H. N. A.

743. Preliminary Results of Ocean Magnetic Observations on the "Carnegie." J. P. Ault. *Terr. Mag*. 34. *pp*. 249–256, *Sept*., 1929.

744. Method for Measuring Susceptibility of Rocks. J. G. Koenigsberger. *Terr. Mag*. 34. *pp*. 209–214, *Sept*., 1929.

Lord Kelvin's mathematical method of electrical images applied to a magnet gives the susceptibility of a body having a plane surface placed near the magnet. The different corrections for varying distance, finite surface area, and finite height perpendicular to the surface are discussed. The method is suitable for use in the field with a variometer to determine the susceptibility of samples of rocks. Crystalline schists and other rocks often exhibit a magnetic anisotropy. A provisional scheme for a magnetic-geological classification of rocks based on remanent magnetism is given. The order of magnitude of remanent induced KF is compared with present values. AUTHOR.

CURRENT ELECTRICITY, MAGNETISM AND ELECTRO-MAGNETISM.

745. Violation of Ohm's Law by Alternating Currents in Circuits containing Capacity and Resistance. M. H. Ahmadi and H. L. Tandon. *Zeits. f. Elektrochem*. 35. *pp*. 471–473, *Aug*., 1929.

The use of alternating currents in electrolytes has been criticised by Ray [Abstract 2261 (1929)] on the ground that Ohm's and Kirchhoff's laws are invalid for such currents. Ray showed, moreover, that the various equivalences proposed between an electrolytic resistance and the resistance of a system of capacities and solid resistances are admittedly false. It is now shown that the simplest combination of capacity and resistance, whether parallel or in series, does not satisfy the two laws mentioned. Further, such equivalences do not give constant values of current and resistance, which are necessarily functions of the time. T. H. P.

746. Electronic Theory of Bad Contacts. H. Pélabon. *Comptes Rendus*, 188. *pp*. 620–622, *Feb*. 25, 1929.

If the conductors are in perfect contact then Ohm's law governs the passage of current and the electrons move amongst themselves with very great velocity. If bad contact predominates, and the conductors are separated by a small interval, the state of affairs may be likened to evaporation of a part of the electrons at one of the surfaces and condensation on the other. This mode of transport is slow and depends on the value of the field. This problem is discussed theoretically for direct and alternating currents as well as for electromagnetic waves. S. G. B.

747. Relation between Hydrogen Pressure and Filament Resistance in a Tube containing Glowing Tungsten. Teresa J. Dillon. *Phys. Soc., Proc.* 41. *pp*. 546–553; *Disc.*, 554–556, *Aug*. 15, 1929.

When a tungsten filament in a tube containing hydrogen is caused to glow, the gas rapidly disappears while the resistance of the filament rises progressively. The latter phenomenon can be used to measure the pressure of the hydrogen. It is suggested that chemical action takes place between the hydrogen and tungsten. AUTHOR.

748. Electrical Conductivities of Liquid Alkali-Metal Amalgams. D. Boohariwalla, G. R. Paranjpe, and M. Prasad. *Indian Journ. Phys.* 4. *pp*. 147–159, *Aug*. 1, 1929.

The electrical conductivities of liquid sodium, potassium and lithium amalgams have been measured by the potentiometer method. The conductivity-concentration curves show breaks at points pointed out by Hine and by Bhatnagar, Prasad and Mukerji. The conduction of current in the amalgams has been shown to be metallic and not electrolytic (1) by resistance-temperature curves, and (2) by measuring the electrical conductivities of the same amalgam with direct and alternating current. AUTHORS.

749. Conductivity of Solid Halogen Compounds of Lead. W. Seith. *Zeits. f. Physik*, 56. 11–12. *pp*. 802–808, 1929.

Tubandt has found that in $PbCl_2$ only the anions show marked movement, while in PbI_2 both ions are mobile. It follows that the relation between the temperature and the electrolytic conductivity must, according to the views of Phipps, Lansing and Cook, show a difference in principle. In the first case the formula $k = Ae^{-\frac{Q}{RT}}$ should hold, and in the second the formula $k = A_1e^{-\frac{Q}{RT}} + A_2e^{-\frac{Q}{RT}}$. Measurements of the conductivity of $PbCl_2$ and PbI_2 show that such a difference exists. H. N. A.

750. Influence of Surface Conditions and Space Charges on the Conductivity of Poor Conductors. K. F. Herzfeld. *Phys. Rev.* 34. *pp*. 791–807, *Sept*. 1, 1929.

To keep a substance non-conducting it is necessary not only that it does not itself generate carriers of electricity, but that these are prevented from entering if good conductors are brought into contact with it. Vacuum and crystals are insulators because the electrons from metal electrodes cannot leave the metal on account of the work function. Water has electrolytic, not electronic conductivity, because ions can be discharged at the electrodes, while electrons cannot permeate the surface directly. The possible types of space charge in a medium containing ions of constant and equal mobility are discussed. It is pointed out that for the potentials which are of interest diffusion plays a rôle only in the immediate neighbourhood of the electrode, and space charge is entirely due to insufficient recombination. Methods of determining the data of interest from space charge curves are given. The number of ions present is always below the equilibrium number. AUTHOR.

751. Ionic Conductivity of Salt Crystals and Field Strength. A. Smekal. *Zeits. f. Physik,* 56. 9–10. *pp.* 579–596, 1929.

The normal fall of the opposing fields by the passage of electricity through pure crystals with soluble electrodes formed a definite linear field distribution. Previous observations were shown to be incorrect owing to the presence of impurities which affected the conductivity to an extent that exceeded the conductivity of the pure crystal. Quartz, calcspar and mica belong to this group. The true ionic conductivity of crystals can be obtained by the use of the temperature law, without the determination of the opposing field or substitution current. The theory of the results was discussed from two points of view. F. J. B.

752. Dependence of Ionic Conductivity of Single Crystals on Field Strength. F. Quittner. *Zeits. f. Physik,* 56. 9–10. *pp.* 597–603, 1929.

The permanent conductivity of natural crystals of sodium chloride and of the purest crystals obtainable from fused rock-salt was measured. It was found that at a temperature of 90° C. the conductivity increased with the field strength. At the lower voltages the increase of conductivity is greater, and at higher field strengths the dependence of the conductivity on the field strength approximated to an exponential law. The increase of conductivity was found to be greater for the natural crystal than for the crystal obtained from the fused salt. F. J. B.

753. Electric Conductivity of Natural and Artificial NaCl Crystals. A. D. Goldhammer. *Zeits. f. Physik,* 57. 3–4. *pp.* 173–185, 1929.

NaCl crystals have from 120° C. to 200° C. a definite value of conductivity. Ohm's law is obeyed up to 600 volts. The polarisation effect was studied with regard to temperature and voltage. From a quantitative study of the conductivity with natural and artificial, pure and impure crystals, it appears that the conductivity is due to the presence of foreign ions in the lattice as with phosphorescence with NaCl and other substances. Previous history of the crystals, especially heat treatment, affects the conductivity in a similar way to the optical properties. J. E.

754. Electrical Penetration and Townsend's Theory. A. v. Hippel and J. Franck. *Zeits. f. Physik,* 57. 9–10. *pp.* 696–704, 1929.

The penetration periods of 10^{-7} to 10^{-8} sec. observed by Rogowski and his co-workers by means of the kathode-ray oscillograph, constitute the principal objection to the basic assumptions of the Townsend collision theory of ionisation. The present authors attempt to show that transition periods of so short a duration as the above may be expected from non-conductors in the stationary state, in which case the space charge may be regarded as an electronic impact phenomena wherein ionic mobility only plays a secondary part. H. H. Ho.

755. Kathode Drop in an Electric Arc. S. S. Mackeown. *Phys. Rev.* 34. *pp.* 611–614, *Aug.* 15, 1929.

By making the assumption that the total kathode drop occurs in a distance less than one mean free path from the kathode, Poisson's equation can be solved. If the experimental values of 4000 amperes per sq. cm., and 10 volts are used for the current density at the kathode, and the kathode drop in a mercury arc, values for the electric field existing at the surface of the kathode can be determined for varying percentages of the current carried by positive ions. If 5 % of the current at the kathode is carried by positive ions, the field existing at the surface of the kathode exceeds 5×10^5 volts per cm. This is probably sufficient to furnish the necessary electron current by " field " currents produced by this high field. The whole kathode drop occurs within a distance of approximately 2×10^{-5} cm., so that the original assumption is justified. AUTHOR.

756. Motion of an Electric Arc in a Magnetic Field under Low Gas Pressure. R. Tanberg. *Nature*, 124. *pp.* 371–372, *Sept.* 7, 1929.

N. Minorsky found under certain experimental conditions that the arc moved in a direction opposite to that which should be expected from the electrodynamical laws governing the movement of a conductor-carrying current in a magnetic field. A space-charge theory was proposed to explain this. In the author's experiments the arc was drawn between straight metal contacts arranged as " arcing horns." The experimental conditions are described. Under the pressures used the arc was found to move in a direction opposite to that when under atmospheric pressure with velocities of several hundred cm. per sec. The results of using electrodes of different metals are given. The theory proposed by Minorsky does not explain this reversed direction of travel under the conditicns described, and another explanation is offered by the author, wherein the emitted vapour shifted in the magnetic field will cause a new kathode spot to develop, which ultimately takes over all the current from the previous kathode spot, thus causing this particular movement of the arc. T. C. H.

757. General Theory of the Plasma of an Arc. L. Tonks and I. Langmuir. *Phys. Rev.* 34. *pp.* 896–922, *Sept.* 15, 1929.

The conception of a random distribution of positive ion velocities is rejected. It is assumed, rather, that each positive ion starts from rest and subsequently possesses only the velocity impressed upon it by the electric field maintained by the balance of electronic and ionic charges. For long mean free paths the motion of positive ions is, therefore, ordered rather than chaotic. On the basis of this assumption the complete plasma-sheath equation has been set up, and the particular cases applying to a series of special cases have been derived. The theory gives two equations. The first, the ion-current equation, provides a new method for calculating the density of ionisation. The potential difference between the centre of the plasma and a non-conducting bounding wall as calculated from this equation gives results in accord with experiment. The second, the plasma-balance equation, provides a method of calculating the rate of ion generation. The values obtained check to within the order of magnitude of those calculated from one-stage ionisation probabilities. This equation completes the number of relations needed to determine completely the conditions in a positive column. The problem of stability in this column is not considered. F. J. W.

758. Rôle of Hydrogen in the Oscillating Arc. E. Z. Stowell and H. E. Redeker. *Phys. Rev.* 34. *pp.* 978–983, *Sept.* 15, 1929.

Experimentally it is found that hydrogen is necessary for the generation of radio-frequency current, but that numerous kathodes, generally of even atomic number, may be used. The spectrum of the oscillating arc shows the Balmer series and the first spark spectrum of the kathode. With the kathode sufficiently hot, the kathode lines disappear, leaving a strong Balmer series on a continuous background. All oscillating arcs of the Poulsen type have about the same high-frequency limit, *viz.*, 5×10^6 cycles per sec. (60 m.). AUTHORS.

759. Removal of Gold from Metallic Kathodes by Glow Discharge. T. Asada and K. Quasebarth. *Zeits. f. phys. Chem.* 143. 5–6. *pp.* 435–455, *Sept.*, 1929.

Copper-gold alloys were found to lose gold when used as kathodes in an atmosphere of air or mercury vapour and exposed to a glow discharge. The removal of the gold was due to the preferential sputtering of the gold as compared with the copper. The diffusion constant of gold in copper was calculated from the initial and final gold content of the kathode, under the assumption that the gold had a zero concentration at the surface of the kathode at the start of the current, and that this zero concentration was maintained. The result obtained was of the order of 10^{-6} cm.^{2} day^{-1} at an estimated temperature of 200° C. F. J. B.

760. Absorption Coefficient for Slow Electrons in Mercury Vapour. R. B. Brode. *Roy. Soc., Proc.* 125. *pp.* 134–142, *Aug.* 1, 1929.

This coefficient measured for velocities from 0·5 to 400 volts. No indication was found for small values of the absorption coefficient, *i.e.*, long free paths at low velocities. A change in the slope of the curve was observed at about 5 volts, a minimum at about 20 volts, and a maximum at 30 volts. A. D.

761. Electron Scattering in Atomic and Molecular Hydrogen. G. P. Harnwell. *Phys. Rev.* 34. *pp.* 661–672, *Sept.* 1, 1929.

An apparatus for generating an electron beam of known energy was designed to rotate about an axis perpendicular to the beam, and through which it passed. Those electrons scattered in the neighbourhood of the axis through a given angle entered an analyser in which an energy spectrum was obtained. The scattering gas was hydrogen admitted from the centre of a discharge tube. When the discharge was in operation it was estimated that more than 60 % of the hydrogen was in the atomic condition. At a given electron velocity and angular setting the electron energy spectrum could be analysed into component peaks which were interpreted as due to elastic, inelastic and ionising collisions. One inelastic loss of about 8 volts was found to occur and several were observed in the neighbourhood of 12·5 volts. From the areas under these peaks the number of electrons scattered through the particular angle could be computed. From these results the number of electrons scattered elastically was plotted as a function of the angle both for the case of atomic and molecular hydrogen. The scattering in both cases was very similar. In the former case the results agreed well within the experimental error with the theoretical curves predicted by quantum mechanics. [See also Abstract 3135 (1929).] AUTHOR

762. Inelastic Collisions in Mercury Vapour. J. D. Whitney. *Phys. Rev.* 34. *pp.* 923–930, *Sept.* 15, 1929.

A narrow beam of electrons from a hot kathode is taken from a space containing Hg vapour and is spread out into a spectrum in a magnetic field. The intensities of the components of the spectrum corresponding to energy losses equivalent to 4·9, 6·7 and 8·8 volts are measured as a function of the initial energy of the electrons. The intensity in each case reaches a distinct maximum within a few volts of the excitation potential of that component. Other energy losses are detected but have such low intensities that they are not measured. AUTHOR.

763. Experimental Investigation of the Electro-Affinity of Gases. M. A. da Silva. *Ann. de Physique*, 12. *pp.* 99–168, *Sept.*, 1929.

The author, in collaboration with Laporte, has shown that the saturated ionisation current (produced by the α-rays of a radioactive substance) is attained in pure argon, at atmospheric pressure, at much smaller continuous voltages than in air. The form of the curves obtained, expressing the currents as a function of applied voltage, showed that the negative ions produced in argon possessed very great mobilities and must, therefore, be constituted of free electrons. This result has been confirmed by a comparison of ionisation curves obtained with continuous and alternating voltages. Mixtures of argon with oxygen and water vapour have been studied, in the former case 0·06 % showing visible deformation of the ionisation curve for pure argon, whilst only 0·04 % was required in the case of water vapour. These data indicate the electronic affinity of water vapour to be at least ten times that of oxygen. By using the method of superficial ionisation, the mobility of positive ions has been found to be 2·2 cm./sec. at atmospheric pressure. The methods which have given a zero value for the electronic affinity of argon show that the electronic affinities of pure nitrogen and hydrogen, although small, are definite, and for hydrogen indicate the existence of very mobile positive ions (greater than 11 cm./sec.). The Wellisch hypothesis for the mechanism of formation of gaseous negative ions is rejected. The period of decrease of polonium is found to be 140·2 days by measuring the ionisation currents in pure argon. H. H. Ho.

764. Factors Affecting the Nature of Ions in Air. H. A. Erikson. *Phys. Rev.* 34. *pp.* 635–643, *Aug.* 15, 1929.

This paper embodies the results of an attempt to determine some of the conditions which affect the nature of ions in air. It is shown that drying agents like $CaCl_2$ and P_2O_5 are not sufficient for drying purposes and that cooling by means of liquid air is essential for the more complete results. In air dried in this manner the initial positive ion transforms into the final ion very slowly, if at all. Results are also given confirming Tyndall, Grindley and Sheppard, that the ionising process itself gives rise to impurities affecting the ions. It is shown that the effect of water is modified by the presence of the impurities due to ionisation. The requirements essential in any method for the study of ions are given at the close of the paper. [See also Abstract 2566 (1929).] AUTHOR.

765. Photoionisation of Some Alkali Vapours. F. L. Mohler and C. Boeckner. *Bureau of Standards, J. of Research*, 3. *pp.* 303–314, *Aug.*, 1929.

Relative measurements of photosensitivity as a function of wave-length have been made by the space-charge method, and absolute values at favourable wave-lengths have been measured by a direct method. Cæsium—The shape of the sensitivity curve is similar to published results and independent of pressure. The photoionisation is proportional to the pressure giving an atomic absorption coefficient *k* of $2 \cdot 3 \times 10^{-19}$ at the principal series limit. Rubidium—The sensitivity curve is similar to cæsium and the value of *k* is $1 \cdot 1 \times 10^{-19}$ at the limit. Potassium—The sensitivity is low at the limit 2856 Å. and rises rapidly from 2600 to 2200 Å. Absorption of cæsium—A rough measurement at low pressure gave a value of 3×10^{-19} at 3100 Å., but with an uncertainty of the same magnitude as the effect measured. Recombination of cæsium—An estimate of the value of *k* for cæsium, based on measurements of the intensity of recombination radiation, gives the same magnitude as the photoionisation value. AUTHORS.

766. Cæsium-Magnesium Photo Cell. V. Zworykin and E. D. Wilson. *J.O.S.A. and R.S.I.* 19. *pp.* 81–89, *Aug.*, 1929.

The values of the work functions of the alkali metals and their colour-sensitivity curves indicate definitely that cæsium is the most favourable material for use in photo cells. The practical difficulties of handling cæsium metal have been overcome in the cæsium-magnesium cell, in which a freshly evaporated coating of magnesium not only binds an invisible layer of cæsium to the walls of the cell, but also provides an electrical connection with the kathode terminal. Average colour-sensitivity curves are given for more than twenty cells. They show that the maximum sensitivity lies at about 4850 Å., as compared with 4400 Å. for pure potassium, 5390 Å. for pure cæsium, and 5560 Å. for the human eye. The photoelectric properties of the cell are detailed by means of response-voltage curves, response-illumination curves and illumination-limit curves. The maximum response for vacuum type cells is about 2 microamperes per lumen, and for gas-filled cells about 25 microamperes per lumen under normal operating conditions. Several commercial applications are described. Further development work is now in progress. AUTHORS.

767. Talbot's Law in Connection with Photoelectric Cells. G. H. Carruthers. *Phil. Mag.* 8. *pp.* 210–213, *Aug.*, 1929.

Oscillograph records are given of the photoelectric current from a cell periodically illuminated by means of a sector disc. These indicate that the fatigue effect associated with obedience to Talbot's law in the case of non-linear cells does not occur *appreciably* in a single exposure of the cell. [See Abstract 3030 (1929).] W. S. S.

768. Longitudinal Distribution of Photoelectrons. A. Carrelli. *Zeits. f. Physik*, 56. 9–10. *pp.* 694–701, 1929.

Starts from Sommerfeld's theoretical treatment, which explained why the number of photoelectrons emitted is greater in the direction of propagation than in the reverse direction. The author has made use of wave mechanics to determine the longitudinal distribution of the photoelectrons, and has obtained a formula which can be made use of for all wave-lengths; whilst Sommerfeld's formula can be regarded as a first approximation, and only for the case where the wave-length is relatively great as compared with the atomic dimensions. In addition to this the new formula discloses a previously unknown relation between the atomic number of the substance emitting the photoelectrons and their distribution. The paper concludes with a table giving results obtained for N_2, Ar and Kr for different wave-lengths. It seems as if the effects of atomic number and hardness of the exciting rays should be measurable. Measurements by Williams, Nuttall and Barlow on N_2 for a single wave-length agree well with the theory.

For heavy atoms, and for very hard rays, there are not many experimental data available. H. N. A.

769. Primary Photoelectric Current in Antimonite. K. H. Voigt. *Zeits. f. Physik*, 57. 3–4. *pp.* 154–162, 1929.

Demonstrates the occurrence of a photoelectric current free from inertia and its proportionality to the incident light in flakes of antimonite covered with a conducting layer of silver produced by vaporisation.
E. E. F. d'A.

770. Effect of Canal Rays on Chlorides of the Alkali Metals. N. Embirikos. *Ann. d. Physik*, 3. 1. *pp.* 91–111, *Oct.* 2, 1929.

The chlorides of the alkali metals were exposed to canal rays in an apparatus which permitted the charge on the salt to be measured. It was shown that canal rays bring about an electron and ion-emission from the chlorides of the alkali metals when the rays are reflected from the salts. The emission of ions increased with the increase in velocity of the canal rays, and also increased, other conditions being constant, with the atomic number of the metal in the compound. The series emission at the surface of the salts took place when a sufficiently great current density was reached; at smaller current densities fluorescence was observed with LiCl and NaCl. In addition to arc lines, NaCl and KCl showed spark lines as well. The arc lines were more intense than the spark lines. The effect of an electric field on the intensity of the spark lines was also determined. F. J. B.

771. Theory of Transition Oscillations. A. Kneschke. *Ann. d. Physik*, 2. 5. *pp.* 555–575, *Aug.* 15, 1929.

By transition oscillations (Ausgleichschwingungen) are meant the oscillations which supervene when the external forces applied to an oscillatory system undergo a sudden change. The general theory is developed first for an *n*-dimensional system and then for a system of infinitely many degrees of freedom. The applied force is assumed to be zero initially, changing at a given instant to a periodic force represented quite generally by a Fourier series. Applications of the general results to two magnetically coupled circuits and to the telegraph cable problem are discussed briefly. Mathematical. W. S. S.

772. Retarded Wireless Echoes. C. Störmer. *Comptes Rendus*, 189. *pp.* 365–368, *Aug.* 26, 1929.

Describes further observations, made at different stations, of the echoes of short electromagnetic waves from currents of electrified corpuscles in cosmic space outside the moon's orbit. During certain periods no echoes were observed, and this is supposed to be due to the unfavourable position of the line joining the earth and the sun, with regard to the earth's magnetic equator; with only one exception echoes have only been observed when the angle between the above line and plane was small. The phenomena give a new method for studying corpuscular currents through space. Some of the echoes have been observed three or four minutes after the signal. H. N. A.

773. Diamagnetism of Some Binary Halogen Compounds. R. Hocart. *Comptes Rendus*, 188. *pp.* 1151–1153, *April* 29, 1929.

In spite of the great number of relative determinations of the magnetisation coefficients of diamagnetic bodies, it has hitherto been impossible to give high precision to such values in support or criticism of the theories involved. The present work undertakes the determination of a small number of these coefficients. The precision of the experiments gives values for liquids to 1 in 1000 and for solids to 3 in 1000. The numbers are based upon the coefficient for water. Hydrochloric acid is first treated and the values given in tabular form. The mean result is given as $22\cdot0 \times 10^{-6}$. For NaCl in solid form the value is given as $30\cdot1 \times 10^{-6}$ and for aqueous solution as $30\cdot8 \times 10^{-6}$. For KCl the values are $39\cdot1 \times 10^{-6}$ for solid and for aqueous solution the value is given $39\cdot60 \times 10^{-6}$ for concentrations about 20 to 100. From the results obtained it is concluded that the diamagnetism of the ions is not strictly additive. It is, therefore, not possible to describe the diamagnetic properties of a body by one coefficient alone. Viewed in this light, the values obtained for a number of substances in the present work, though differing from those of other workers, are in satisfactory agreement with those of Pascal. S. G. B.

774. Diamagnetism of Azoxyanisol Crystals and the Larmor Theorem. G. Foëx. *Comptes Rendus*, 188. *pp.* 1154–1155, *April* 29, 1929.

The values found for the principal coefficients of diamagnetism of crystals of para-azoxyanisol are as follows: along the axis of symmetry, $6\cdot65 \times 10^{-7}$; in the plane of symmetry, $6\cdot34 \times 10^{-7}$; and $4\cdot08 \times 10^{-7}$. A discussion follows on the variation of these values under different conditions and it is shown that the Larmor theory is not valid in the strictest sense for the particles (atoms or ions) contained in a single atomic nucleus.

S. G. B.

775. Anomalous Diamagnetism of Graphite. S. Paramasivan. *Indian Journ. Phys.* 4. *pp.* 139–145, *Aug.* 1, 1929.

It is a very remarkable fact that " amorphous " carbon has about the same diamagnetic susceptibility as diamond, $0\cdot47 \times 10^{-6}$, while nevertheless following Debye and Scherrer, its X-ray pattern is usually considered as analogous to that of crystalline graphite which has a far larger susceptibility ($4\cdot2 \times 10^{-6}$). In an attempt to find an explanation of this anomaly an examination has been made of the magnetic properties of purified carbon from different sources. The results, taken together with the X-ray evidence, suggest that amorphous carbon differs from graphite in its ultimate structure, and this is supported by the known differences in their chemical and physical properties such as density and electrical conductivity. It is suggested that the behaviour of graphite may be analogous to that of bismuth, which has been discussed by Ehrenfest. AUTHOR.

776. Diamagnetism and Wave Mechanics. F. Bitter. *Phys. Zeits.* 30. *pp.* 497–504, *Aug.* 15, 1929.

The induced moment of a molecule in a magnetic field is derived from Schrödinger's equation, and assuming a uniform distribution of molecular orientations the susceptibility x of a fluid is shown to equal

$$\tfrac{2}{3}\mathrm{N}\sum_{l=n}\left(\frac{|\mathrm{M}_l^n|^2}{W_0(l)-\mathrm{W}_0(n)}\right)-\frac{e^2}{6mc^2}\sum_{j=1}^{\mathrm{S}}\overline{r^2}$$

where N is the number of molecules per unit volume and M_l^n is the magnetic moment corresponding to a quantum transition between states of energies

V.
19

$W_0(l)$ and $W_0(n)$ respectively. The negative term in the expression is identical with that deduced classically for the diamagnetic susceptibility. The first term is zero if the molecule possesses spherical symmetry, *i.e.*, if it is an atom. Influence of nuclear motion is investigated, and although a diamagnetic orientation does occur, extremely high field strengths would be required to make the effect perceptible. It is also shown that the magnetic moment of a rotating dipole is too small to affect susceptibility measurements. The paper concludes with a discussion of the diamagnetism of the elements in the solid form, from an empirical standpoint. W. S. S.

777. Apparatus for the Measurement of Magnetic Susceptibility. W. Sucksmith. *Phil. Mag.* 8. *pp.* 158–165, *Aug.*, 1929.

The force acting on the substance tested in a non-uniform magnetic field is measured by hanging it from the bottom of a circular ring of strip phosphor-bronze, fixed at the top, and having two mirrors attached at points on the top half, equidistant from the point of support, in such a way that a horizontal beam of light striking one of them is reflected back to the other, which reflects it so that its direction is nearly the same as the original one. When the ring is loaded and distorted the final direction of the beam changes, and the deflection can be measured on a scale. An accuracy of 0·5 % is obtained with substances of moderate specific susceptibility, and for susceptibilities of 10^{-6} it is within 1 %, using half a gramme of material. The movement of the specimen is very small, so that it is not necessary to employ a null method, $H\,dH/dy$ hardly varies in the small distance moved through. H. N. A.

778. Induction Coefficients for Magnetometer Magnets. H. E. McComb. *Terr. Mag.* 34. *pp.* 241–247, *Sept.*, 1929.

A special apparatus was designed for the investigation of induction coefficients of magnetometer magnets by Lamont's method. Maximum accuracy is secured when the vertical distance between magnets is equal to one-half the horizontal distance. Tests were made over wide ranges of horizontal and vertical distances. AUTHOR.

779. Magnetic Susceptibility of Nitric Oxide at 296° K. and 216° K. F. Bitter. *Nat. Acad. Sci., Proc.* 15. *pp.* 638–642, *Aug.*, 1929.

The test body consisted of four parallel tubes A, B, C and D of pyrex glass placed in contact with one another so that their centres lay on the corners of a horizontal square. C and D contained a paramagnetic gas (air), while A and B communicated with the gas contained in the vessel in which the test body was suspended, and which was placed between the poles of an electromagnet. Observations were made with different pressures of the nitric oxide, and temperatures of 296° K. and 216° K., the latter being produced by a bath of solid CO_2; the numerical result obtained was $\Theta^2_{296°}/\Theta^2_{216°} = 1{\cdot}08$; the value calculated from van Vleck's results is 1·07. H. N. A.

780. Structure of Atomic Magnet in Ferromagnetic Bodies. R. Forrer. *J. de Physique et le Radium*, 10. *pp.* 247–262, *July*, 1929.

An article which collects and combines the results described in previous papers. [See Abstracts 2457 and 2960 (1926).] G. E. A.

781. Statistical Calculation of Remanent Magnetisation. L. Néel. *J. de Physique et le Radium*, 10. *pp.* 263–266, *July*, 1929.

The remanent magnetism is calculated, in terms of the saturation value, for a substance of confused crystalline structure in which the magnetic mechanism is that suggested by Forrer. [See preceding Abstract.] G. E. A.

782. Some Aspects of the Problem of Magnetism. W. Gerlach. *J. de Physique et le Radium*, 10. *pp.* 273–282, *Aug.*, 1929.

The themes discussed are: (1) Atomic magnetic moment and space quantisation. (2) Magneto-optic experiments and the symmetry of the magnetic atom. It is now known that the orientation of the atoms in a magnetic field confers no birefringent property on a gas. This points to a spherical symmetry of the atom. (3) The Weiss magneton and spacial quantisation: J. Becquerel has found that the magneto-optic effect is due to a single electron. (4) Susceptibility of alkaline vapours: observations on potassium indicate that the calculation of its susceptibility rests on the laws of spacial quantisation. (5) Constancy of the atomic moment: it is found to vary with thermal effect and with change of constitution. (6) Diamagnetism of gases: the susceptibility of diamagnetic gases is independent of temperature and pressure. (7) Atomic and electronic problems in ferromagnetism: no new species of carrier is required for ferromagnetism; it is very probable that the free electron acts in this capacity. The paramagnetism of ferromagnetic metals above their Curie points is of a third variety, which is different from those which obtain in ions and in atoms. G. E. A.

783. Ionic Magnetic Moments. E. C. Stoner. *Phil. Mag.* 8. *pp.* 250–266, *Aug.*, 1929.

In the first transition series of ions the incomplete group of electrons belongs to the group of highest total quantum number, while in the rare earth series it belongs to an "inner" group. Interaction between an ion and its neighbours affects mainly the electrons of highest quantum number, so it may be expected to follow different laws in the above two series. The moment of the rare earth ions in Weiss magnetons is $p = 4{\cdot}97g\sqrt{j(j+1)}$. In the first transition series the orbital moment l and the spin moment s must be considered separately; l is not fully effective, owing to the interaction field. It is shown that the p value should lie between $4{\cdot}97\sqrt{4s(s+1)}$ and $4{\cdot}97\sqrt{4s(s+1)+l(l+1)}$ according to the interaction, tending to the former value at low and the latter at higher temperatures. This agrees satisfactorily with experimental results. H. N. A.

784. Electronic Theory of Ferromagnetism and Electric Conductivity. F. Bloch. *Zeits. f. Physik*, 57. 7–8. *pp.* 545–555, 1929.

In a recent publication by Dorfman, Jaanus and Kiksin [see Abstract 2830 (1929)] the question has been raised as to whether the electrons, which according to Heisenberg's theory are responsible for ferromagnetism, are likewise the cause of electrical conductivity. This possibility is discussed in the present paper, and shown to depend among other things upon the null-point energy. An elementary derivation is given of the formula for the energy centre and multiplicity of the different term systems for any initial grouping of cells. H. H. Ho.

785. Magnetisation Diagram of Nickel Monocrystals. G. J. Sizoo. *Zeits. f. Physik*, 57. 1–2. *pp.* 106–114, 1929.

Describes a method of producing nickel monocrystals in the form of long wires. After sufficiently long heating the crystals show the characteristic magnetisation diagram, which has already been obtained in the case of iron. In this, above a certain point, change in magnetisation takes place without hysteresis; below this point hysteresis is always present, and the " virgin " curve shows one or several sudden changes of direction. The remanance depends on the orientation of the crystal, and apparently has its highest value in the direction of the tetragonal axis. When the " ideal " hysteresis curve of Steinhaus and Gumlich is measured the ideal initial susceptibility is found to be infinite, or at any rate a very large quantity. H. N. A.

786. Discontinuities of Magnetisation in Iron and Nickel. C. W. Heaps and J. Taylor. *Phys. Rev.* 34. *pp.* 937–944, *Sept.* 15, 1929.

These have been observed in iron and nickel and recorded photographically. The number corresponding to a given small change of magnetising force has been determined for different speeds of magnetisation. For high speeds there appear to be more and smaller discontinuities as the speed is slightly reduced. If the speed is greatly reduced, however, there are fewer discontinuities in ordinary specimens than for high speeds. The length of the portion of material associated with each discontinuity is estimated to be 2 or 3 mm.; the volume is of the order 10^{-7} cm^3. The specimen, on an elastic support, is mounted on the axis of a solenoid and its deflection measured with a microscope when currents of varying magnitude flow through the solenoid. For a small piece of nickel wire it is found that the loop is made up of a few discontinuities separated by uniform changes of magnetisation. It is suggested that in different portions of the material different magnetostrictive effects may occur. Thus strains are set up which, when relieved discontinuously, produce the jumps of induction. AUTHORS.

787. Structure and Magnetic Susceptibility of the Copper-Gold System. H. J. Seemann and E. Vogt. *Ann. d. Physik,* 2. 8. *pp.* 976–990, *Sept.* 15, 1929.

The dependence of the diamagnetic susceptibility of solid solutions of copper and gold was found, and it was shown that the susceptibility of Cu_3Au was greater than that of CuAu, and that $CuAu_3$ was greater than CuAu but less than Cu_3Au. These results are partially explained on the basis of the lattice structure of the solutions. G. E. B.

788. Statistical Interpretation of Maxwell's Equations. M. S. Vallarta. *J. Math. Phys., Mass. Inst. of Technology,* 8. *pp.* 155–161, *July,* 1929.

The equations of Dirac's quantum theory of the electron embody the dualism de Broglie wave-electron, and are furthermore interpretable in terms of probabilities, the probability of an *electron* being in a given volume element and of its crossing a given surface element. It is shown in the present note that Maxwell's electromagnetic equations can be written in a form similar to Dirac's and that a statistical interpretation can then be introduced in terms of the probability of a *photon* being in a given volume element and of its crossing a given surface element. W. S. S.

789. Propagation of Plane Electromagnetic Waves in a Spherically Symmetrical Gravitational Field. W. Alexandrow. *Phys. Zeits.* 30. *pp.* 480–485, *Aug.* 1, 1929.

The propagation of plane electromagnetic waves in a weak symmetrical spherical gravitational field is discussed. From the physical standpoint it is desirable that light radiation describes geodetical zero lines, and the Einstein "ray bending" (Strahlenablenkung) is electrodynamic in form. The propagation of light, therefore, appears as in a medium the dielectric and permeability factors of which are variable. The subject is treated mathematically so that the bent light rays are deduced as field lines of the Poynting radiation vector. Finally, remarks are made on the "pseudo energy density" of the spherical gravitational field, and the Faraday-Maxwell theory of the gravitational field is shown to be ultimately deduced. S. G. B.

790. Experimental Verification of Electromagnetic Equivalence between Maxwell Displacement Currents and Conduction Currents. R. van Cauwenberghe. *J. de Physique et le Radium*, 10. *pp*. 303–312, *Aug*., 1929.

In the field of a large air condenser with parallel plates is placed a ring formed of a pile of plates of high permeability iron parallel to the plates and midway between them. There are two windings on this ring, one A with a large number of turns, and the other B with only ten. The two plates of the air condenser are connected to the poles of a high-tension alternator. An alternating displacement current passes through the opening in the iron ring, and produces an alternating magnetic flux round it; as a result of this alternating e.m.f.'s are produced in the coils wound on the ring, and that in A is connected to a d.c. galvanometer through a vibrating rectifier. The exact numerical relation between the current in A and the flux of electric induction through the opening of the iron ring can be arrived at with the help of the winding B, and shown to agree with theory. It is also possible to find the value of the velocity of propagation of electromagnetic waves in air with this apparatus. H. N. A.

791. Quantum Electrics of G. Mie. A. Landé. *Zeits. f. Physik*, 57. 11–12. *pp*. 713–722, 1929.

Mie's quantum electrics [see Abstract 1949 (1928)] is based on a Hamiltonian expression for the electromagnetic field, from which is derived a complex second order wave equation for the probability amplitude ψ. The present author modifies Mie's wave equation by reducing it to equations of the first order. The special case of the theory, which in Mie's original theory corresponded to a point electron, now gives the Dirac equations for a spinning electron. The significance of Maxwell's equations in the new theory is discussed. W. S. S.

APPARATUS AND INSTRUMENTS.

792. Kinematographic Recording Galvanometer. S. Bayne-Jones and L. V. Foster. *J.O.S.A. and R.S.I.* 19. *pp*. 73–77, *Aug*., 1929.

An image of a watch face and one of a scale reflected from the mirror of the galvanometer are formed side by side on the photographic film of a cinematograph camera. This is arranged to make exposures of suitable length, and is provided with a driving mechanism for shifting the film into new positions at suitable time intervals. H. N. A.

793. Construction of Large Electromagnet. A. Glaser. *Phys. Zeits*. 30. *pp*. 472–477, *Aug*. 1, 1929.

A fully detailed specification and mode of construction of a large electromagnet at the Physics Institute of the University of Munich. Details of the functioning of the various parts and dimensional and other details are given. S. G. B.

794. New Apparatus for Registration of Indications of Uni- and Bifilar Electrometers. O. Mathias and V. F. Hess. *Phys. Zeits.* 30. *pp.* 508–512, *Aug.* 15, 1929.

This paper describes a new form of photographic apparatus based on the registration instrument designed by Kolhörster for the purpose of recording ultra-radiation. Besides the latter phenomena, most of the other observations may be registered which are usually made by means of uni- and bifilar electrometers. The description is too detailed for an Abstract and should be consulted in its entirety. H. H. Ho.

795. Use of Quadrant Electrometer as a Ballistic Energy Meter. P. D. Morgan and S. Whitehead. *Journ. Sci. Instruments,* 6. *pp.* 241–247, *Aug.,* 1929.

This paper describes how the quadrant electrometer may be employed as a ballistic energy meter. The theory of the method is given by which its performance as a ballistic instrument may be predetermined from a knowledge of its periodic time and sensitivity as a voltmeter. Test results are given showing that results calculated from the theory are in excellent agreement with experiments. The quadrant electrometer used in this way may be employed for recording the energy released during very short time intervals, such as when a fusible cut-out or circuit breaker operates under short-circuit conditions. The method given is applicable to either a.c. or d.c. circuits, and has given satisfactory results in the test house of the Electrical Research Association where it has been in use during the last three years. AUTHORS.

796. New Precision Variable Air Condenser. W. H. F. Griffiths. *Journ. Sci. Instruments,* 6. *pp.* 297–302, *Sept.,* 1929.

In the usual type of vane condenser it is necessary to use very fine workmanship to maintain the moving vanes accurately central between the fixed plates. This difficulty is avoided in the condenser described in this paper, the chief feature of which is that the gaps are in series instead of being in parallel. In this case the total capacity depends solely on the sum of the gaps, and hence is independent of slight eccentricity of the moving member. The moving plates, which are not normally connected to the external circuit, are of coppered glass. G. E. B.

RADIOGRAPHY AND ELECTROPHYSIOLOGY.

797. Difficulties of Comparative Radiography of the Chest. J. V. Sparks. *Brit. J. of Radiology,* 2. *pp.* 325–329; *Disc.,* 329–330, *July,* 1929.

A discussion, with examples, of some of the difficulties to be met with in the production of a series of radiograms of uniform and satisfactory depth and detail. W. V. M.

798. Source of Error in the Measurement of Dosage. A. E. Barclay, G. Stead and S. F. Cox. *Brit. J. of Radiology,* 2. *pp.* 401–402, *Aug.,* 1929.

The actual thickness of filters of copper or zinc are not always those marked on them and the differences may be such as to cause serious variation in intensity. W. V. M.

CHEMICAL PHYSICS AND ELECTROCHEMISTRY.

799. Adsorption Regress. H. Freundlich and L. L. Burgess. *Zeits. f. Elektrochem.* 35. *pp.* 362–366, *June,* 1929.

Under certain conditions solutions of lead acetate and sodium sulphide precipitate lead sulphide which quickly changes its specific surface magnitude; thus, whereas the lead sulphide precipitate at first adsorbs large quantities of dyestuff, with time the dyestuff is expelled into the liquid medium, this being an example of adsorption regress. The adsorption regress for basic and acidic dyestuffs is investigated. J. K.

800. Adsorption as a Function of Polarisation. The Adsorption Isotherm. J. H. de Boer and C. Zwikker. *Zeits. f. phys. Chem.* 3. *Abt. B.* 6. *pp.* 407–418, *June,* 1929.

A three-constant formula is proposed for the adsorption isotherm for those cases wherein complex molecular adsorption of vapours occurs in the neighbourhood of the saturation pressure. The relationship between vapour pressure π and the value of the adsorbed films n is expressed by $\log \frac{\pi}{K_3\pi_0} = K_2K_1^n$, wherein π_0 represents the saturated vapour pressure. The experimental data obtained are shown to agree closely with the proposed formula. J. K.

801. Theory of Adsorption of Gases. A. Magnus. *Zeits. f. phys. Chem.* 142. *Abt. A.* 6. *pp.* 401–430, *Aug.,* 1929.

A comprehensive theory of the adsorption of gases is developed on the hypothesis that gaseous molecules are adsorbed as dipoles by the operation of purely electrostatic forces. The temperature coefficient of the heat of adsorption calculated from the theory is found to be in good agreement with experimental results. Considering the adsorbed phase as a mobile two-dimensional gas an equation of state is derived for this phase. The curves based on this equation agree fairly satisfactorily with observed values over a wide range of pressure. The observed variation of heat of adsorption with pressure corresponds qualitatively with that calculated. The relation between heat of adsorption and pressure can be represented quantitatively by an equation of the type required by the theory having empirically determined constants. The values of these constants and of the initial inclination change in a uniform proportion from one isotherm to another. A. J. M.

802. Linear Adsorption. R. S. Bradley. *Phil. Mag.* 8. *pp.* 202–204, *Aug.,* 1929.

Linear adsorption at the three-phase line is studied on the basis of surface thermodynamic activity. Expressions are deduced for (1) such activity in terms of the two-dimensional pressure; (2) surface concentration (an expression developing into the Langmuir isotherm under certain conditions); and (3) adsorption at a line. [See also Abstract 2323 (1929).] C. A. S.

803. Internal Pressures in Adsorbed Films. P. G. Nutting. *Washington Acad. Sci., J.* 19. *pp.* 295–300, *Aug.* 19, 1929.

A definite relationship exists between the concentration or thickness of the adsorbed film of dissolved or adsorbed gas, and the external temperature and pressure. Simple thermodynamic definitions of kinetic and cohesive pressures are given, which are applicable to any homogeneous system on equilibrium. Simple relationships between internal pressures and contration were contrasted with equations of state. Principles were developed and applied to the calculation of surface tension directly from vapour pressure. Cohesive pressure in the adsorbed films was derived from vapour pressure and temperature data. F. J. B.

804. Adsorption of Air and Water Vapour on Rock-Salt Surfaces. J. H. Frazer. *Phys. Rev.* 34. *pp.* 644–648, *Aug.* 15, 1929.

With a method previously described the adsorption of air on rock-salt surfaces is measured as a function of temperature, and the temperature at which complete outgassing occurs is determined. An estimate of the thickness of the film is given, and also the approximate speed at which it forms. The effect of water vapour on the surface is observed, and it is shown that exposure to water vapour has no permanent effect on the surface as long as its partial pressure is kept below that of a saturated sodium chloride solution at the same temperature. This, however, is true only of cleavage surfaces; polished surfaces are less stable against the action of water vapour. [See also Abstract 1682 (1929).] AUTHOR.

805. Adsorption Phenomena in Systems of Several Constituents. C. Wagner. *Zeits. f. phys. Chem.* 143. 5–6. *pp.* 389–396, *Sept.*, 1929.

From the results of measurements of the surface tension of aqueous solutions of aniline and phenol together, the adsorbed quantities of these two components in the water-air surface layer are calculated. Within certain limits the presence of one constituent enhances the adsorption of the other, this mutual effect being by no means negligible. A similar phenomenon is observed with pyridine, the relatively slight adsorption of which from ethyl alcohol solution is appreciably increased by addition of salicylic acid. In general, increase of the adsorption by such addition occurs if corresponding mutual forces exist between the true adsorptive and the added compound on the one hand, and between the added compound and adsorbents on the other. T. H. P.

806. Proof of Adsorbed Layers by Means of Electron Waves. E. Rupp. *Zeits. f. Elektrochem.* 35. *pp.* 586–589; *Disc.*, 589–590, *Sept.*, 1929. *Paper read before the Deut. Bunsen Gesell., Berlin, May,* 1929.

A stream of electrons was generated by an incandescent wire and allowed to fall at a definite angle on to the surface of the crystal. The reflected electrons were measured, and the determination was repeated for the same crystal surface upon which hydrogen, nitrogen and hydrogen sulphide had been adsorbed. The crystals used were single nickel crystals and pure iron. The method was utilised to show the effect of nickel and iron as catalysts in the formation of ammonia. F. J. B.

807. Adsorption and Gaseous Friction. C. Drucker. *Zeits. f. Elektrochem.* 35. *pp.* 640–644; *Disc.*, 644, *Sept.*, 1929. *Paper read before the Deut. Bunsen Gesell., Berlin. May,* 1929.

The coefficients of viscosity of binary gaseous mixtures do not vary linearly with the molecular composition and mostly show maxima. The view is expressed that the curvature of the viscosity curve is particularly great when the two components are adsorbed to widely differing extents. The viscosity is investigated mostly in glass tubes, and study of the adsorption of mixtures on glass wool shows that, at any rate for carbon dioxide and water vapour, the thickness of the adsorbed layer considerably exceeds that of a monomolecular layer. This must exert an influence on the viscosity, but of still greater importance is the circumstance that the composition of the gaseous mass must vary along the radius of the tube, so that the friction is always exerted between layers of dissimilar composition. The hydrodynamic theory of the streaming under such conditions can be developed only if the static fall in concentration is known. The linear equation $\eta_{\text{lin.}} = \eta_1 \cdot \mu_g + \eta_2 (1 - \mu_g)$, where μ_g is the molecular fraction corresponding with η_1, may, however, be replaced by the formula $\eta = \alpha \cdot \eta_{\text{lin.}} + f\ (\mu_w,\ \mu_g)$, where μ_w is the molecular fraction in the adsorbed layer and α that fraction of the radius from the middle of the tube within which the viscosity may, with sufficient approximation, be assumed to obey the linear law. Certain assumptions lead, for $CO_2 - H_2$ mixtures to the expression $\eta = \eta_c \cdot \mu_g + \eta_H(1 - \mu_g) + \zeta(\epsilon - \epsilon^2)$, where μ_g refers to CO_2, ϵ is the relative mean concentration difference between the wall and the non-varying gas region, and ζ is a constant independent of the composition and hence of ϵ and having the dimensions of a coefficient of viscosity. These considerations are found to be in satisfactory agreement with the data available for various gaseous mixtures. T. H. P.

808. Frenkel Adsorption Isotherm. F. J. Wilkins and A. F. H. Ward. *Nature*, 124. *p*. 482, *Sept*. 28, 1929.

The different temperature coefficients of the saturation maxima given by the Langmuir and Frenkel adsorption isotherms are shown to be due to an error in the deduction of the latter. The corrected isotherm is $\frac{s}{m} = \sigma_0 \left(1 + \frac{\sqrt{2\pi mkT}}{p_0\sigma_0\tau_0} \cdot e^{-\mu_0/KT}\right)$ which gives a saturation maximum s/σ_0 which is independent of the temperature. F. J. W.

809. Calorimetric Determinations of Heat of Adsorption. A. Magnus and H. Giebenhain. *Zeits. f. phys. Chem*. 143. 3–4. *pp*. 265–277, *Sept*., 1929.

A new highly sensitive and accurate adsorption calorimeter is described. This has been employed in measurements for extremely low equilibrium pressures with wood charcoal and silicic acid gel at two different temperatures. In these determinations carbon dioxide was used as the adsorbed gas. J. K.

810. Sorption of Sulphur Dioxide, Carbon Dioxide and Nitrous Oxide by Activated Carbon. D. O. Shiels. *J. Phys. Chem*. 33. *pp*. 1386–1397, *Sept*., 1929.

The adsorption of carbon dioxide, nitrous oxide and sulphur dioxide by German activated gas-mask charcoal at 25° C has been determined from 0 to 40 mm. pressure for the first two gases, and from 0 to 22 mm. pressure for the last. The adsorption process is reversible in the case of carbon dioxide. In the cases of nitrous oxide and sulphur dioxide hysteresis occurs. The log V, log p/P curves for carbon dioxide and nitrous oxide coincide. The log V, log $p\sigma/P$ curves for the first two gases are parallel straight lines, that for sulphur dioxide being straight for part of the range considered and parallel to the other two. The adsorption of nitrous oxide and carbon dioxide may be represented by Patrick's equation $V = K(p/P)^{1/n}$. AUTHOR.

811. Heat of Adsorption of Gases by Solids. K. F. Herzfeld. *Am. Chem. Soc., J.* 51. *pp.* 2608–2621, *Sept.*, 1929.

It is shown that the increase in heat of adsorption with the amount of gas adsorbed can be explained by the interaction of the dipoles in neighbouring molecules which are set up if we assume that the adsorption is mainly due to electric forces. In this case the interaction can be much stronger than the usual heat of evaporation would lead us to expect. The thermodynamical difficulty connected with an increase in heat of adsorption is discussed. It is shown that the best explanation seems to be the formation of groups of adsorbed molecules sticking together. The equilibrium pressures of different gases with the same heat of adsorption are compared. AUTHOR.

812. Adsorption of Mercury Vapour by Activated Charcoal. D. O. Shiels. *J. Phys. Chem.* 33. *pp.* 1398–1402, *Sept.*, 1929.

The adsorption of mercury vapour by activated charcoal has been determined at room temperature (12–14 ° C) in a vacuum. The weight adsorbed is of the order of 0·2 mg. per gram of charcoal. Experiments were done to test the adsorption of mercury vapour by activated charcoal in presence of air. No definite indication of such adsorption was found. AUTHOR.

813. Heat of Dilution. J. Perreu. *Comptes Rendus*, 189. *pp.* 285–287, *Aug.* 5, 1929.

Measurement of the limiting heats of solution of hydrated salts by measuring the heats of dilution, or by measuring the heats of addition of a small quantity of water to a large mass of the saturated solution. These alternatives give concordant results. [See also next Abstract.] A. D.

814. Determination of Heats of Dilution of Hydrated Salts (Second Method). J. Perreu. *Comptes Rendus*, 189. *pp.* 462–465, *Sept.* 23, 1929.

The previous method described by the author for the determination of heats of dilution and addition [see preceding Abstract] was hardly trustworthy for feeble variations of temperature and a more suitable procedure is now discussed. Data are given for $Na_2CO_3 . 10H_2O$, $Na_2SO_4 . 10H_2O$, $BaCl_2 . 2H_2O$ and $CuSO_4 . 5H_2O$. H. H. Ho.

815. Solubility of Cellulose Derivatives. Parts I and II. E. W. Mardles. *Kolloid Zeits.* 49. *pp.* 4–16, *Sept.*, 1929.

Part I.—The maximum quantity of a cellulose derivative soluble in a solvent is difficult to ascertain, since such derivatives are heterogeneous and do not dissolve until they have undergone change, as indicated by their swelling. A more practical and simpler method of judging of the solvent power of a liquid for cellulose derivatives consists in determining the solubility number or dilution ratio. With an acetone solution of cellulose acetate or nitrate, much larger additions of benzene and alcohol than of pentane are necessary to cause turbidity, and it seems that neither benzene, alcohol, water, nor any lower member of a homologous series serves as an inert diluent. Determination of the temperature at which a liquid changes from solvent to non-solvent also furnishes a means of measuring the solvent power. Cyclohexane is a better solvent than benzyl alcohol, as its solutions are stable at −17° C., whereas those in benzyl alcohol begin to gelatinise or opalesce at 25° C. [see Abstract 2021 (1923)]. Part II.—Measurements of the swelling and solvent powers of mixtures of benzyl alcohol and anisole for various products show that for cellulose acetate, maximum swelling and solubility appear for the 30 % anisole mixture. T. H. P.

816. Solubility of Iodine in Carbon Dioxide Gas. H. Braune and F. Strassmann. *Zeits. f. phys. Chem.* 143. 3–4. *pp.* 225–243, *Sept.*, 1929.

The vapour pressure of iodine was determined over the temperature range 32·6 to 98·5° C. The method employed was the streaming method. Hydrogen gas evolved by electrolysis was used to transport the vapour of iodine from tubes in the thermostat to the absorption vessel. The increase of the saturation concentration of iodine vapour in the presence of carbon dioxide was measured over the same temperature range and at pressures from 1 to 50 atmospheres. The results indicated that the attraction coefficient for $I_2 - CO_2$ was inversely proportional to the temperature. The heat of solution of iodine in carbon dioxide at a concentration of 1 mol. per litre was about 1000 cal. per molecule of iodine. F. J. B.

817. Solute Molecular Volumes in Relation to Solvation and Ionisation. D. O. Masson. *Phil. Mag.* 8. *pp.* 218–235, *Aug.*, 1929.

The published data of the specific gravity of aqueous solutions of a number of substances have been studied. In most cases the apparent solute molecular volume of an electrolyte is a rectilinear function of the square root of the concentration. In some cases, for high concentrations, the graph begins to curve suddenly, this happens at the point where a definite hydrate is formed. With H_2SO_4 this is the monohydrate. Higher hydrates occur for HNO_3, HCl, NH_4NO_3 and LiCl. The author concludes that where the graph is a straight line the solution is that of a hydrate in excess of water; when the curve begins the solution is not truly an aqueous one, but either a solution of a monohydrate in excess of anhydrous substance or a mixture of hydrates. The apparent solute molecular volume in a few instances is negative at low concentrations; the true volume (that of the hydrate) is always positive. It is suggested that the true volume at infinite dilution is that of the ionised hydrate, and the larger measured molecular volume at any higher concentration is the average value for a mixture of ionised and unionised molecules. The ionisation fraction at any given concentration can be calculated. It is assumed that any solvent water in the hydrate solution retains practically its original specific volume. Three poor electrolytes are also dealt with. H. N. A.

818. Influence of Solubility and Solvation in Non-Aqueous Salt Solutions. P. P. Kosakewitsch. *Zeits. f. phys. Chem.* 143. 3–4. *pp.* 216–224, *Sept.*, 1929.

Alkali halides depress the solubility of carbon dioxide in methyl, ethyl and n-butyl alcohols and acetone. In ethyl alcohol the influence of lithium is greater than that of sodium, and the influence of iodine greater than that of chlorine, bromine occupying an intermediate position. With methyl alcohol, similar relationships are observed, except that the influence of chlorine is greater than that of bromine. In concentrated solutions the salts (1 molecule) combine with from 3 to 5 molecules of methyl or ethyl alcohol, and at infinite dilution with 7 to 10 molecules. T. H. P.

819. Thermodynamic Behaviour of Concentrated Solutions. R. Fricke. *Zeits. f. Elektrochem.* 35. *pp.* 631–640; *Disc.*, 640., *Sept.*, 1929. *Paper read before the Deut. Bunsen Gesell., Berlin, May,* 1929.

The results of Fricke and Havestadt's measurements of the vapour pressure of concentrated solutions [*Zeits. f. Elektrochem.* 33. *pp.* 441–455; *Disc.*, 455, 1927] showed that, for solutions with high positive heats of dilution, in the very concentrated regions, the differential heat of dilution, $U = RT^2\frac{\delta enp/p_0}{\delta T}$, is greater than the differential work of dilution, $A = RTenp_0/p$, whereas for the more dilute solutions the inverse is the case. Results are now given of vapour-pressure measurements on aqueous solutions of thorium and ammonium nitrates, glycerol, sodium hydroxide and urea of various concentrations at 0° C. and 10 (or 15)° C. For magnesium chloride and sodium acetate the values of U calculated according to Kirchhoff's expression given above approximate to and run parallel to the observed calorimetric values. With sodium hydroxide and zinc chloride the agreement is comparatively good, and the same is the case with glycerol, but thorium nitrate shows marked disagreement throughout. It seems possible that the heats of swelling of water-poor gels might also be deduced by calculation from vapour-pressure data, the exact calorimetric measurement of heats of swelling being very difficult. T. H. P.

820. Rate of Dissolution of Zinc Alloys in Hydrochloric Acid. P. Fischer. *Zeits. f. Elektrochem.* 35. *pp.* 502–505, *Aug.*, 1929.

Zinc (Kahlbaum) is alloyed with Ag, Sb, As, Pb, Hg, and Pt, plates of sheet metal are cast and cut up into squares of 2 cm. side, the edges are covered with wax, and the specimens immersed in hydrochloric acid; the interval (of 1 minute or more) before the appearance of hydrogen evolution is called the induction period. The induction period of zinc in $0 \cdot 5N$HCl is 1 or 2 days, in $1N$ acid 11 minutes; for zinc with 10 % Pt, it is 5 minutes; for zinc with 5 % Hg, 48 hours. The order of the metal is Pt — Sb — Ag — As — Pb — Hg, Pt accelerating the rate of dissolution in 0·5 and 1 normal HCl, Hg retarding it. The effect increases with the quantity of the other metal, but not proportionately, and there is no parallelism with the Volta series. But the order of the decreasing rate of dissolution is the same as the order of increasing supertension of hydrogen at the alloy. Metals of low supertension accelerate the dissolution of zinc, metals of high supertension retard it. The theory of local couples can alone explain the phenomena, but only when the numbers and relative positions of the local couples are taken into consideration. These, however, are uncertain and change with the mode of preparation of the alloy. H. B.

821. Thermolysis of Solid Substances. Ludwig-Soret Phenomenon. H. Reinhold. *Zeits. f. Elektrochem.* 35. *pp.* 627–631; *Disc.*, 631, *Sept.*, 1929. *Paper read before the Deut. Bunsen Gesell., Berlin, May,* 1929.

When two cylinders of compressed mixtures of cuprous and silver iodide, rendered homogeneous by prolonged heating, are brought into contact and then heated to different degrees, there is a transference of ions across the contact face, the cuprous iodide concentrating at the cold end, the silver ions at the hot end [see Abstract 2612 (1929)]. The concentration change amounted, with a temperature difference (between the two cylinders) of 90°, to 30 mol. %. But the transference depends also upon the general temperature range, and decreased as the maximum temperature was raised from 300° to 430°, to less than 1 %, though the temperature difference was increased to 235°. There are α and γ ranges of the mixed crystals in question; in the α range (higher temperatures) a temperature change makes little, in the γ range much difference in the transference. A heterothermally heated system of mixed crystals is in thermolytic equilibrium when an ionic migration in any direction, due to an electric field, does not give rise to a change in concentration as is the case in isothermally heated homogeneous mixtures. The phenomenon is connected with the electrolytic conductivity and the thermoelectric homogeneous effect of Benedicks. In chains of electrolytically-conducting solid salts of the type $\underset{\longleftarrow}{\text{Ag}\overset{T_1}{|}\text{Ag}\times\overset{T_2}{|}\text{Ag}}$ and $\underset{\longleftarrow}{\text{Cu}\overset{T_1}{|}\text{Cu}\times\overset{T_2}{|}\text{Cu}}$ (where $T_2 > T_1$), the kations travel in the direction of the arrows. When two salts with common anion are combined to a purely electrolytic thermocouple, as in $\underset{\longrightarrow}{\overset{\longleftarrow T_2 \longrightarrow}{T_1\text{Ag}_2\text{S}|\text{Cu}_2\text{S}T_1}}$ and $\underset{\longleftarrow}{\overset{\longleftarrow T_2 \longrightarrow}{T_1\text{AgBr}|\text{CuBr}T_1}}$ ($T_2 > T_1$), the upper arrows indicate (on short-circuiting) the difference of the homogeneous opposite effects of the two salts, which induce a transference of the kations in the direction of the lower arrows. In the sulphides (and also in the iodides) the silver ions would migrate to the hot end, the copper ions to the cold end; in the bromide the directions would be the opposite. [See also Abstracts 1775 (1925) and 201 (1928).] H. B.

822. Dispersoid Synthesis of Gold Chloride by Means of Alkaline Formaldehyde Solutions. P. P. v. Weimarn. *Kolloid Zeits.* 48. *pp.* 346–352, *Aug.*, 1929.

In 1923 the author published experiments on the dispersoid synthesis of gold chloride by means of formaldehyde containing caustic potash or potassium carbonate. The experiments, made with ordinary distilled water and glass vessels, and their interpretation were criticised by Zsigmondy. He therefore repeats the experiments with pure reagents and in vessels of various glasses, platinum and gold and confirms his former results. The only noteworthy effect of higher purity is that the concentration by evaporation of the solution, at which the red gold particles turn blue or violet, can be increased. When the proportion of formaldehyde and of KOH is insufficient, the reduction and the change, blue into red, are very slow. When potassium carbonate is used, gold carbonate and double carbonates may possibly be formed. The red gold solutions are very stable. H. B.

823. Possibility of Characterising Kinetic Processes in Heterogeneous Systems by Standardised Conditions of Stirring. W. Heller. *Zeits. f. phys. Chem.* 142. 6. *pp.* 431–452, *Aug.*, 1929.

The present paper deals with the kinetics of the solubility of a few metals in aqueous salt solutions, as for example tin and cadmium in FeCl_3 solution, and of magnesium in NH_4Cl solution. The influence of temperature and stirring on the velocity constants are specially considered. The experimental results obtained indicate a few relationships which allow the expressing by exact characteristics of a few kinetic processes in heterogeneous systems. J. K.

824. Theory and Methods of Ultra-Centrifuging. O. Lamm. *Zeits. f. phys. Chem.* 143. 3–4. *pp.* 177–190, 1929. *Arkiv f. Mat. Astron., och Fysik, Stockholm*, 21. *B.* 2. *pp.* 1–4, 1929.

The differential equation for the ultra-centrifuge is discussed, and a theory for the combined sedimentation and diffusion of a dissolved substance in a centrifugal field, in a sector-shaped vessel, is developed. Concentration changes are followed by an application of the known bending of a ray of light. The materials used in the development of the methods are starch and proteins. The method is shown to be specially applicable to cases where several substances in mixed solutions have to be investigated. The use of the method for the study of sedimentation equilibria is indicated.

F. J. B.

825. Mechanism of Gelatinisation. F. L. Usher. *Roy. Soc., Proc.* 125. *pp.* 143–151, *Aug.* 1, 1929.

A fairly uniform suspension of gamboge in water was prepared, with particles of radius about $4 = 10^{-5}$ cm., and no appreciable number of smaller size. This was mixed with various proportions of solutions of sodium chloride, and examined with an ordinary microscope, under which the individual particles were visible. It was found necessary to coat the inner surfaces of slide and cover glass with a thin film of acid sodium stearate, which was found to prevent the attachment of the gamboge particles in rows along slight fissures or scratches in the glass surface, masking the action in the suspension. Union of single particles has been observed to form extended aggregates, which link up to form an irregular open structure. The compactness depends on the electrolyte concentration. When this is high the particles link up to form dense aggregates so rapidly that these do not join together to form a coherent structure or gel, and a precipitate results. With very small electrolyte concentration single particles in Brownian motion were observed and a few doublets, some of which broke up. A suspension of cadmium sulphide can also be caused to gelatinise by means of sodium chloride at suitable concentration.

H. N. A.

826. Influence of Volume in Swelling. Dorothy J. Lloyd. *Kolloid Zeits.* 48. *pp.* 342–345, *Aug.*, 1929.

It is frequently found that the swelling of gels is the greater, the greater their volume. Most of such experiments were, however, made with commercial gelatin containing 1 to 2 % of ashes ($CaSO_4$). When purified isoelectric gelatin [prepared as explained by Lloyd and Plaass, *Biochem.* J. 21. p. 1352 (1927)] is used, the swelling in water, salt solution and acids is independent of the volume, provided that there be no hydrolysis of the gelatin. This hydrolysis is always observed in alkaline solutions. The influence of volume in commercial gelatin is due to a diminution during the experiment of the relative concentration of the impurities in the gelatin which consist of electrolytes and decomposition products of protein.

H. B.

827. Diffusion in Gelatin. V. Morávek. *Kolloid. Zeits.* 49. *pp.* 39–46, *Aug.*, 1929.

The author describes his experiments in connection with his measurements with potassium bichromate on the diffusion of lead nitrate from its aqueous solutions into aqueous solutions of gelatin, agar and agar-gelatin. The growth of the precipitation rings with time in certain cases can be expressed by a parabolic equation. The diffusion of the lead ions into the agar gel is directly proportional to the concentration of the lead ions in the aqueous solution. The depth of the precipitation rings in gelatin with lowering of the potassium bichromate concentration is directly proportioned to the concentration of the lead nitrate in the aqueous solution. With higher concentrations of potassium bichromate the reaction proceeds periodically with the increasing concentration of lead nitrate. A dynamical equilibrium between the gel and the aqueous phases is considered to be the cause for the minima. At minimum diffusion the adsorption combinations between the bichromatic ions and the gel are equal in value to the chemical attractions between the bichromate and lead ions. J. K.

828. Solidification of Gelatin. M. Bergmann and B. Jacobi. *Kolloid. Zeits.* 49. *p.* 46, *Sept.*, 1929.

According to Katz and Gergrosz, gelatin stretched to 300–400 % gave Röntgen diagrams of the same nature as for the unstretched thread. The present authors examined mechanically, *e.g.*, by investigating the tearing strengths, the behaviour of stretched and unstretched strips of gelatin. J. K.

829. General Solvatation of Colloidal Systems. Wo. Ostwald. *Kolloid Zeits.* 49. *pp.* 60–74, *Sept.*, 1929.

The general solvatation equation proposed by the author some time ago, *viz.*, $P = RT\,.\,c/M + bc^n$ (where P is the osmotic pressure directly measured, $c =$ g./c.cm., b and n are constants), has now been tested on a variety of materials (12 tables of data are included) and found to apply unusually well to sols of caoutchouc, gutta-percha (Caspari, Kroepelin and Brumshagen), nitrocellulose in acetone (Duclaux), gelatin (Kunitz), and hæmoglobin (Adair) over the whole range of concentration investigated. From the equation, the molecular weight of such sols in the respective dispersion medium may be calculated from the expression $RT/M = \lim.[P/c]_{c=0}$, *i.e.*, from the limiting value which the otherwise very variable micelle-weight attains at infinite dilution. Of the solvatation constants b and n, the latter is very frequently though not necessarily 2 approx., but the values of b are very characteristic colloid-chemical constants, decreasing strongly with depolymerisation and showing remarkable growth with rising temperature (caoutchouc, gelatin). The earlier view that not only gels but also sols can swell, and that the osmotic pressure of a sol in a micelle packed cell consists of the normal van't Hoff pressure + solvatation pressure, has been confirmed throughout this investigation. H. H. Ho.

830. Theory of Colloidal Osmosis. W. Haller. *Kolloid Zeits.* 49. *pp.* 74–83, *Sept.*, 1929.

The osmotic pressure of colloidal solutions does not obey the van't Hoff law, $P = cRT$, for highly dispersed solutions. In many cases the deviations depend on secondary influences, *e.g.*, variation of degree of dispersion, electrostatic ionic forces. It may also be shown theoretically that purely molecular-kinetic processes must often lead to deviations from the van't Hoff equation, which latter must, therefore, only represent a special case. Whilst with molecular disperse solutions the (kinetic) osmotic pressure only proceeds from the motion of translation of the molecules, there are nevertheless many colloidal solutions in which independent special motions of the micelles can work osmotically. Therefore, to the van't Hoff translation pressure must be added further components which are due to the oscillations and rotations of the micelle parts. The equation for the total osmotic pressure, taking into account the micelle volumes, is given as $P = c'RT + c'^2RT(0 \cdot 46N_L\gamma\phi)$, where c' is the concentration of the solvent in mol./litre, γ is the number of particles capable of oscillation in a micelle, and ϕ is the volume of the amplitude of a micelle. The equation agrees with that of Ostwald (*Kolloid Zeits.* 24. 7. 1919), which, therefore, acquires a kinetic significance. This equation has been confirmed by the osmotic data of many investigators, and deviations from it appear to proceed only from secondary influences. The alteration of caoutchouc under the influence of heat and light is explained as a diminution of the product $\gamma\phi$, *i.e.*, as a diminution of elasticity and an increased inner rigidity of the caoutchouc micelles.

H. H. Ho.

831. Colloidal Chemical Factors in Formation and Disintegration of Crude Oil Emulsions. A. Lottermoser and N. Calantar. *Kolloid Zeits.* 48. *pp.* 362–377, *Aug.*, 1929.

The patent literature on this subject is reviewed and discussed. The effectiveness of casein as an emulsifier for petroleum is again established, but the concentration of 0·2 % casein recommended by Seifriz for Baku oil is found to be insufficient. In general, casein forms oil in water emulsions when refined petroleum is used. The presence of hydrophobic colloids in petroleum, *e.g.*, in the emulsification of an unrefined oil with casein, gives rise to both types of emulsion at suitable concentrations. Hard asphalt and petroleum tar lower the boundary surface tension between oil and water, and form elastic skins at the surface which include water. They also raise the viscosity of petroleum and thereby favour the stability of natural petroleum emulsions, those with hard asphalt being the more stable. Extraction of the tar with alcoholic caustic soda disintegrates natural petroleum emulsions. Adsorption of the asphalt bodies by shaking an emulsion with Fuller's earth leads generally to disintegration. Precipitation of the asphalt and tar with anhydrous tin tetrachloride gives rise to spontaneous disintegration. The lowest boiling fractions of petroleum are only feebly emulsified, and this fact may be explained by the low viscosity of the fractions, their poverty with respect to emulsion-forming colloids, and the great difference between the specific gravities of the two phases. Sapamine-acetate, hydrochloride and lactate are unsuitable either for the emulsification of petroleum or for the disintegration of emulsions.

H. H. Ho.

832. Structure of Gels. Gels Obtained with Salts of Quinine, Optoquine and Eucupine. P. Thomas and Marie Sibi. *Comptes Rendus*, 189. *pp.* 292–294, *Aug.* 5, 1929.

Reference is made to the transformation into the crystalline state of certain jellies such as arabinosazone, the acetal of sorbite and benzoylcystine, etc. An analogous phenomenon has now been observed for the uranate of lithium, amyl alcohol, ethyl acetate and benzene accelerating the crystallisation. Encouraged by these observations, the authors attempted with success to convert the jellies of quinine, optoquine and eucupine salts into the crystalline condition. The phosphates and chlorhydrates were employed. [See also Abstract 3216 (1927).]

J. K.

833. Pectography of Colloidal Solutions of Metallic Sulphides. P. Bary and J. V. Rubio. *Comptes Rendus*, 189. *pp.* 294–296, *Aug.* 5, 1929.

A micrographic study is recorded of the behaviour on drying of such colloidal solutions as the sulphides of antimony, arsenic, mercury, cadmium, zinc, molybdenum and copper. J. K.

834. Action of X-Rays on Colloidal Solutions. S. S. Bhatnagar, R. S. Gupta, K. G. Mathur and K. N. Mathur. *Zeits. f. Physik*, **56. 9–10.** *pp.* **684–693, 1929.**

With colloidal solutions of silver, gold, negative copper hydroxide, positive copper hydroxide completely dialysed and positive iron hydroxide completely dialysed, no marked alteration in the cataphoretic wandering velocity was observed after exposure to X-rays. The above sols were "protected," while most of the sols used by Crowther and Fairbrother, who observed colour alterations explained by a dispersion of the sol particles, were "unprotected." The remarkable difference in the behaviour of dialysed and undialysed sols, when treated with X-rays, makes it necessary to assume that the X-rays do not attack the sol particles directly, but by means of the electrolytes contained in the undialysed sol. The action of X-rays on the chlorides of Fe and Cu was investigated, and it was found that in both cases hydrolysis took place, which caused an increase in mobile H^+ ions, and so an increased conductivity. H. N. A.

835. Hydrogen and Carbon Monoxide in Metals after Fusion in a Vacuum. A. Villachon and G. Chaudron. *Comptes Rendus*, 189. *pp.* 324–326, *Aug.* 12, 1929.

The metals are fused in a magnesia crucible within a spiral of nichrome or graphite at a gas pressure of 1/50 mm. near 1700° and 1/500 mm. near 1000°. The fused metal is rolled out to foil, 0·1 mm. thick, and these foils are then heated for many hours in pyrex glass or silica to expel the gases retained. They consist of hydrogen, carbon monoxide and a little of some carbonaceous gas, not nitrogen. In aluminium the gas evolution did not stop after heating for 900 hours to temperatures rising from 230° to 600°. Electrolytic nickel, copper and iron, kept fused at 1600° to 1850° and then heated in the solid state to 800° or 600° for 6 hours at the time, gave, *e.g.*, 3·6 c.c. of hydrogen per 10 g. Ni. Aluminium, kept fused at 800° and heated solid to 600° gave 1 c.c. of hydrogen in 5 hours. These quantities of H_2 are of the order of magnitude of the gas volumes which the melting metal would retain at atmospheric pressure according to Sieverts and Iwasé. Neither fusion nor repeated heating to higher temperatures can expel all the H_2 and CO, nor can distillation and casting in a vacuum. Hydrogen and carbon monoxide seem to be retained by the metals as hydrides and carbonyls of extremely small dissociation pressures. H. B.

836. High Temperature Modification of Manganese. E. Persson and E. Öhman. *Nature*, 124. *pp.* 333–334, *Aug.* 31, 1929.

The results of experimental work on manganese and various alloys of manganese are given, and it is concluded that the highest critical point found by M. Gayler at 1191 ± 3° represents the transition point $\gamma - \beta$. As β-manganese is very brittle at room-temperatures and γ-manganese is malleable, the transition should be accompanied by a sudden change in mechanical properties. It is found that both α- and β-manganese are much less brittle at 600° than at room-temperatures, and at 900° the β-manganese is malleable although hard; at 1160° the hardness is still considerable, but at 1200° the metal becomes extremely soft. C. O. B.

837. Structure of Face-Centred Metals after Rolling and Annealing. v. Göler and G. Sachs. *Zeits. f. Physik*, 56. 7–8. *pp.* 477–502, 1929.

An X-ray examination (after severe rolling) has been made of Al, Cu, Ni, Au, Ag and constantan. The crystallographic relations between the deformed lattice and the direction of rolling has been determined. Similar observations have been made after annealing. Some of the mechanical properties of the solid materials have been measured. A. A. D.

838. Theory of the Recrystallisation of Pure Metals. U. Dehlinger. *Ann. d. Physik*, 21. 7. *pp.* 749–793, *Sept.* 4, 1929.

An extended theoretical and experimental study has been made of the recrystallisation of pure metals. It is found that, above and below the temperature of recrystallisation, the rate of grain growth is entirely different. It is suggested, therefore, that the temperature of recrystallisation be defined as that temperature at which the rate of grain growth undergoes a sudden change. Further, the results appear to show that recrystallisation involves at least two consecutive processes: (1) the general weakening of the structural forces ("Auflösung der Verhakungen") a change which is not indicated by X-ray photographs, but which determines the temperature of recrystallisation; (2) the recovery or grain formation as a result of the state of strain existing in the deformed metal. F. J. W.

839. Kinetics of the Passive State. W. J. Müller. *Zeits. f. Elektrochem.* 35. *pp.* 656–669; *Disc.*, 669–670, *Sept.*, 1029. *Paper read before the Deut. Bunsen Gesell., Berlin, May*, 1929.

The paper discusses the kinetics of the passive state of a number of metals. Measurements of the passive state were made by means of an oscillographic recording of the current-time-voltage curves for the various metals in different electrolytes. The conclusions arrived at as a result of the study were that definite evidence was obtained in deciding whether the passive state was due to a chemical reaction or to a passive surface layer, and that chemical passivity required a certain definite current density for its establishment. Chemical passivity was preceded by a surface layer passivity. Experimental data were obtained to explain the behaviour of a metal under each of the conditions. F. J. B.

840. Spatial Arrangement of Atoms in Alloys. A. Westgren and A. Almin. *Zeits. f. phys. Chem.* 5. *Abt. B.* 1. *pp.* 14–28, *Aug.*, 1929.

The variation of the linear space lattice arrangements with the composition was determined for the α-phase for a series of alloys. The alloys investigated were silver-aluminium, copper-aluminium and nickel-aluminium. The results indicated that the space lattice parameter was not an additive function of the parameter of the components. From the dimensions of the space lattice the volumes per atom were calculated for these systems, so far as their structure was known, and also for the phases of the systems, Cu-Zn, Ag-Zn, Ag-Cd, Cu-Mg and Fe-W. The results show that the formation of intermediate phases in these alloys is accompanied by a contraction. The contraction is especially great for the phases in Ni-Al. The cause of this phenomenon is suggested. F. J. B.

841. Structure of Heusler Alloys. E. Persson. *Zeits. f. Physik*, 57. 1–2. *pp.* 115–133, 1929.

From an X-ray examination of a series of alloys it is concluded that the magnetic phase possesses a body-centred cubic lattice, with the aluminium atoms so distributed that they form a superposed face-centred lattice. The phase is, however, only magnetic when the manganese content exceeds a certain minimum. This view is supported by the results obtained from a series of alloys of composition (Cu, Mn)$_3$Al with varying manganese. An analogous structure is found for the magnetic phase in the Cu, Mn, Sn system. A. A. D.

842. Structure of Heusler Alloys. S. Valentiner and G. Becker. *Zeits. f. Physik*, 57. 5–6. *pp*. 283–291, 1929.

Heusler alloys of a composition corresponding approximately with Al(Cu, Mn)$_3$ have been studied. Measurements of the change in length and lattice type on annealing with simultaneous observation of the magnetic properties have failed to reveal any relationship between these properties and the existence of a definite phase on lattice type. F. J. W.

843. X-Ray Analysis of Copper-Antimony and Silver-Antimony Alloys. A. Westgren, G. Hägg and S. Eriksson. *Zeits. f. phys. Chem.* 4. *Abt. B.* 6. *pp*. 453–468, *Aug.*, 1929.

An X-ray analysis of a series of Cu-Sb alloys has completely confirmed the equilibrium diagram suggested by Carpenter. Antimony can dissolve in copper up to a limiting concentration. The crystal parameter for copper increases from 3·608 Å. for pure copper to 3·66 Å. for the saturated copper phase. At normal temperature for concentrations of 19–25 % of antimony atoms, a CuSb phase having hexagonal close packing whose dimensions increase with antimony concentration from $a_1 = 2\cdot72$ Å., $a_3 = 4\cdot32$ and $a_3/a_1 = 1\cdot59$ to $a_1 = 2\cdot750$ Å., $a_3 = 4\cdot349$ Å. and $a_3/a_1 = 1\cdot582$. The Cu$_2$Sb phase has a simple tetragonal lattice with six atoms in the unit cell ($a_1 = 3\cdot992$ Å., $a_3 = 6\cdot091$ Å.). This structure is analogous to Fe$_2$As. X-ray analysis of a series of Ag-Sb alloys has shown that the equilibrium diagram of Petrenkos is not correct. The maximum solubility of Sb in Ag. is about 5 atoms % of Sb. The silver parameter increases with antimony concentration from 4·078 Å. for pure silver to 4·113 Å. for the saturated phase. At normal temperature from 10–16 % Sb a phase of hexagonal close packing is observed whose parameters increase with antimony content from $a_1 = 2\cdot921$ and $a_3 = 4\cdot775$ to $a_1 = 2\cdot959$ Å. and $a_3 = 4\cdot786$. From 20–25 % Sb another intermediate phase is obtained, a hexagonal close packing of very similar structure, but must be rhombohedral and have the following dimensions: 20 % Sb, $a_1 = 2\cdot981$, $a_2 = 5\cdot196$, $a_3 = 4\cdot802$; 25 % Sb, $a_1 = 2\cdot988$, $a_2 = 5\cdot239$, $a_3 = 4\cdot842$. W. V. M.

844. Oxidation-Reduction Reactions and Meaning of Chemical Combination. Part I. B. Jirgensons. *Zeits. f. Elektrochem.* 35. *pp*. 352–358, *June*, 1929.

Reference is made *inter alia* to the work of Thomson, Müller and Kossel [see Abstract 641 (1916)]. The useful definition of oxidation and reduction as an increase or lowering respectively of the positive or as a lowering or increasing of the negative value is examined with the help of a few inorganic and organic oxidation-reduction reactions, for polar as well as non-polar combinations. J. K.

845. Active Nitrogen. P. K. Kichlu and S. Basu. *Indian Journ. Phys.* 4. *pp*. 161–173, *Aug.* 1, 1929.

Reference is made to the theories of Klein and Rosseland and of

Sponer. It is observed that present-day opinion favours the point of view of Sponer. Experimental evidence is brought forward to throw light on this subject. *Inter alia*, experiments are given showing the factors on which the life of active nitrogen depends. The Saha and Sur arguments based on the Klein and Rosseland's theory of excited molecules as amended by Birge appear to explain the experimental results obtained.

J. K.

846. Electronic Interpretation of Oxidation and Reduction. W. A. Noyes. *Am. Chem. Soc., J.* 51. *pp.* 2391–2396, *Aug.*, 1929.

There seem to be at least three types of oxidation reactions, the first being due to the transfer of an electron from one atom to another. The author regards sodium as being oxidised by chlorine, the electrons of two sodium atoms being transferred to a molecule of chlorine. In the second type of oxidation reaction there is addition of a positive hydroxyl group $\mathrm{H}:\underset{..}{\ddot{\mathrm{O}}}{}^{+}$ to an unshared pair of electrons, either of a negative ion or of an electrically neutral molecule. In the latter case a hydrogen ion separates, and a semipolar union is formed; this explanation has been given for the oxidation of trimethylamine to trimethylamine oxide by hydrogen peroxide. In the third type there is separation of a semipolar oxygen atom in an electrically neutral condition, followed by its union with an unshared pair of electrons. The oxygen atom may either remain in the semipolar condition in the new compound, or may take up a hydrogen ion and form a hydroxyl group.

H. N. A.

847. Decomposition of Carbon Monoxide in the Silent Electric Discharge. Part III. R. W. Lunt and L. S. Mumford. *Chem. Soc., J. pp.* 1711–1723, *Aug.*, 1929.

Experiments previously reported [see Abstract 2422 (1927)] have been continued, using an ozoniser in which the final combustion of the solid decomposition product can be effected *in situ*, thus avoiding absorption of water during manipulation. Using carefully dried carbon monoxide, with elaborate precautions to exclude moisture from the apparatus, the reaction velocity is found to be independent of the nature of the electrode (dilute sulphuric acid or dry mercury), and the decomposition, which proceeds readily, shows no evidence of attaining equilibrium within 18 hours. The presence of malonic anhydride, C_3O_2, in the gaseous phase is confirmed, and explains the analytical results of Schutzenberger. An aqueous solution of the brown solid produced during the discharge contains oxalic acid. The brown solid is not identical with polymerised malonic anhydride, but is probably a mixture containing some of that substance.

A. J. M.

848. Chemical Effects of Semi-Corona Discharge in Gaseous Hydrocarbons. S. C. Lind and G. Glockler. *Am. Chem. Soc., J.* 51. *pp.* 2811–2822, *Sept.*, 1929.

Reference is made to two previous papers [see Abstracts 2600 (1928) and 339 (1929)]. It is now shown that the lower hydrocarbons, methane, propane, butane and ethylene, like ethane, condense to liquid and solid hydrocarbons in the semi-corona discharge. The liquid products are extremely complex. A close correlation appears to exist between the refractive index, molecular weight, density, colour and viscosity for these liquid products. The value of these physical factors increase in the inverse proportion to the yield.

J. K.

849. Decomposition of Ethylene by Ultra-Violet Light. R. B. Mooney and E. B. Ludlam. *Faraday Soc., Trans.* 25. *pp.* 442–445, *Aug.*, 1929.

It has been shown that ethylene is decomposed by light of wave-length shorter than 210 $\mu\mu$, giving acetylene as one of the products of decomposition. The presence of Hg vapour is not essential for the decomposition, contrary to the statement of Bates and Taylor. The ultra-violet absorption spectrum of ethylene has been studied. The long wave-length limit of absorption, *viz.*, 210–213 $\mu\mu$, coincides with that calculated from the heat of dissociation of ethylene to acetylene and atomic hydrogen. AUTHORS.

850. Kinetics of Oxidation of Ethylene. H. W. Thompson and C. N. Hinshelwood. *Roy. Soc., Proc.* 125. *pp.* 277–291, *Sept.* 2, 1929.

The possibility of chain mechanism in the oxidation of ethylene between 400° and 500° has been investigated by methods previously followed [see Abstract 1761 (1928)], variations in the reaction being measured by the rate of pressure increase. It is shown that (i) the reaction velocity increases continuously with pressure up to explosion with no sharp transition; (ii) pressure affects the rate as in a reaction of the third order, the partial pressure of ethylene influencing it approximately proportionally to the third power of its concentration, that of oxygen having little effect; (iii) increased surface seems to lower the rate; (iv) heat of activation varies from 35,000 cal. for 100 mm. ethylene and 300 mm. oxygen to 43,000 cal. for 150 mm. ethylene and 300 mm. oxygen; (v) addition of argon or nitrogen exercises a very slight and erratic accelerating effect. These results, and especially (ii), (iii) and (iv), are held to point to a bimolecular activation process and short chains. C. A. S.

851. Quantum Relations of Activation. F. London. *Zeits. f. Elektrochem.* 35. *pp.* 552–555; *Disc.*, 555, *Sept.*, 1929. *Paper read before the Deut. Bunsen Gesell., Berlin, May,* 1929.

On the basis of a simplifying hypothesis of rigid atoms, the author obtains a good picture of the order of phenomena of reaction and activation, by the application of methods analogous to those of a force-potential. A. D.

852. Effect of Cohesion of Medium on Reaction Velocity. Velocity of Interaction of N-Chloroacetanilide and Hydrobromic Acid in Aqueous Solutions. Minnie Richardson and F. G. Soper. *Chem. Soc., J. pp.* 1873–1884, *Sept.*, 1929.

A reaction in which the products are of greater cohesion than the reagents is accelerated by solvents of high cohesion, whilst if the products are of lower cohesion than the reagents the reaction is retarded by such solvents. The solvent has little effect when products and reagents are substances of like cohesion. The cohesion of the solvent more directly affects the activity velocity (van't Hoff) coefficient than the concentration velocity coefficient, and when the cohesion of the medium is constant the activity velocity coefficient is constant. The theory is confirmed by observations on the reaction: $C_6H_5 . NClAc + HBr \rightarrow Br . C_6H_4 . NHAc + HCl$ in various aqueous media. A. J. M.